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JULY, 1956

PIPE LINE INDUSTRY

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CONSTRUCTION • OPERATIONS • MAINTENANCE

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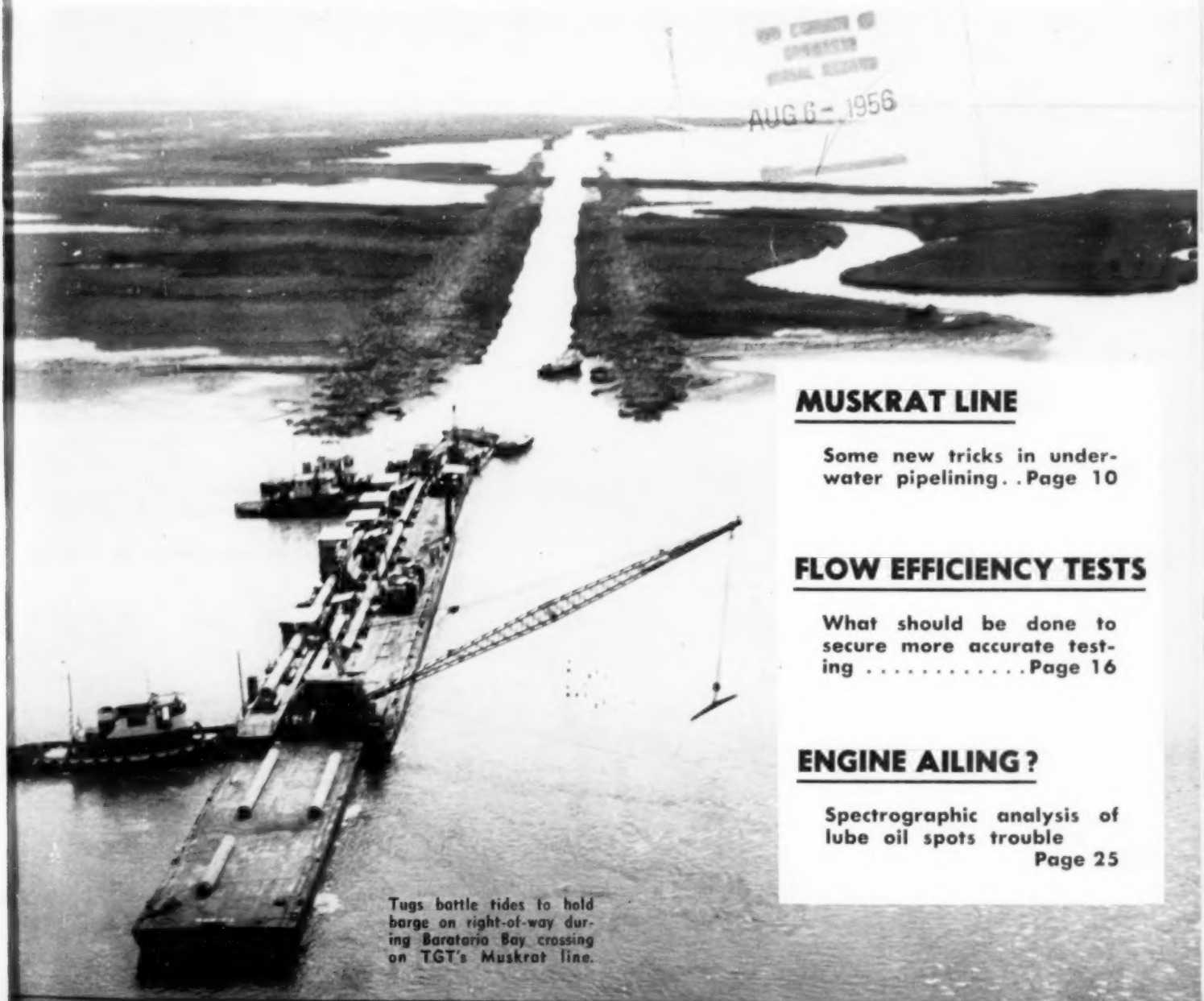

Tugs battle tides to hold barge on right-of-way during Barataria Bay crossing on TGT's Muskrat line.

MUSKRAT LINE

Some new tricks in underwater pipelining . . Page 10

FLOW EFFICIENCY TESTS

What should be done to secure more accurate testing . . . . . Page 16

ENGINE AILING?

Spectrographic analysis of lube oil spots trouble Page 25

rn the page for additional contents and Quick Review of this issue

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Tulsa, Oklahoma

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PIPE LINE INDUSTRY

CONTENTS and Quick Review

July, 1956 Vol. 5, No. 1

To help you put first things first, scan these time-saving digests, checking those you want to read first.

Longest Underwater Pipe Line Nears Completion

☐ Contractors devised some new tricks to solve the problems that confronted them in laying Tennessee Gas Transmission Company's 355-mile long "Muskrat" line in south Louisiana. More than 285 miles of this line was laid using various submarine pipelining methods. Lay barges were modified to speed up construction and one Mississippi river crossing was pulled in catenary across the river bottom. Methods developed on this line will mean progress in building future offshore pipe lines.

Melvin A. Judah ..... Page 10

More Accurate Flow Efficiency Tests

☐ Record growth of gas pipe lines since World War II has focused attention on the need for more accurate efficiency tests. With this as a goal, AGA research points up need for standardizing testing procedures and then taking care to get accurate field measurements. This article includes their recommendations.

R. F. Bukacek and Rex T. Ellington ..... Page 16

What Engineers Are Asking About Flow Testing

☐ Research is bringing steady progress in improved techniques for determining accurate flow efficiencies. At the Eleventh Annual Short Course in Gas Technology, Texas A&I College, Kingsville, engineers had the chance to ask questions that arise most frequently in their work. Read the answers given by a panel of industry leaders ..... Page 22

Lube Oil Tests Reveal Engine Ailments

☐ Spectrographic analysis of lube oils gives maintenance men an insight into the condition of engines and compressors while in operation. Such engine troubles as ring and cylinder wear, bearing failure, air filter troubles, and excessive crankshaft wear can be predicted in more than half the cases. It promises more economical maintenance schedules and allows engines to operate longer and then be shutdown for overhaul just before failure occurs.

J. L. Wilson ..... Page 25

Take the Pulse of Compressor Piping

☐ Hours of engineering calculations can be saved by the electro-acoustical analog developed at Southwest Research Institute for designing compressor station piping. Engineers represent a complete compressor station piping network by electric circuits to design new stations and to modify existing ones. This article explains how 30 problems already have been solved.

Glenn Damewood ..... Page 30

Getting the Most from Pump Seals

☐ Modern pipe line pumps put a premium on performance of mechanical seals to prevent losses and hazards. With increased use of automatic control, seal operation must be virtually perfect. Here are some ideas to help you install and maintain them properly.

Ted J. Sniffen ..... Page 34

Are You a Good Supervisor?

☐ Here are many new ways in which a merit rating program can be used to evaluate job performance. Check yourself on the self-analysis chart.

Robley D. Stevens ..... Page 44

Give 'Em a Chance to Grow

☐ Pipe line companies are faced with the critical problem of developing enough qualified executives to meet their needs. Here is an expert's analysis of the pitfalls to watch in grooming employes for top jobs, plus an eye-opening description of the three attitudes management has regarding employe development.

William E. Bright, Jr. ..... Page 48

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"Those who know us best like us best," so—

Let the Public Know!

The public "thinks we are a bunch of rich, overbearing braggarts with a tax gimmick."

These acid words were spoken by a man who should know—Jake L. Hamon, chairman of the American Petroleum Institute. That such a thought should even enter an oil leader's mind, let alone be printed, forms the basis for one of the most glaring paradoxes on the American scene.

The public can hardly deny that it took more—much more than braggarts with a tax gimmick to play a principal role in winning two world wars—to lift this country from mediocrity to unquestioned world leadership—to make American's transportation system, farm productivity, heating methods and production lines the finest in the world.

The public can hardly deny that—within an average life span—men with sheer guts and a willingness to lose everything they owned, transformed oil into a $40 billion industry, second only to agriculture.

Nor can anyone deny that in 1955 the oil industry:

- Was composed mostly of small companies competing sharply with each other.
- Paid more federal taxes than any other industry (nearly $5.5 billion, excluding employe income taxes).
- Averaged less than 10 percent on investment and less than 4 percent net profit, almost exactly the same as for industry as a whole.
- Paid the second highest wages and salaries in the nation.
- Offered employe benefits excelled by few—if any—other industries.
- Had one of the lowest labor turnover records of any industry.
- Had fewer strikes than most industries.
- Topped most industries in contributions to science, technology and education.

Yet at the same time the price of oil and its products has increased so slightly as to be almost indiscernible compared with other commodities.

The public cannot deny any of these true facts—nor can they confirm them. Why?

Because the public doesn't know!

The public doesn't know because the oil industry expends too much of its public relations effort either talking to itself or hiding behind a cloak of righteous conservatism.

The millions of words passed from oil leaders and trade publications to other oil men expounding the need for public relations—the risks oil men take—how outstanding the industry is, creates not one ounce of public understanding or good will for the industry.

The oil industry's conservative "open the door a peek" attitude toward the press, i.e., releases telling about a new wildcat being drilled in some county to attempt to test some formation and that the project is contracted for so many feet in depth, *without the slightest mention of estimated cost*—expansion releases describing new construction in "square feet" *with no mention of estimated cost.* Such actions of intentional omission does not create better understanding of the industry.

No wonder the newspapers and critics yell "propaganda!" when oil attempts to explain its side in a crisis. No wonder the public eats up sensational news stories about the antics of a minute few addle-brained "Johnny come lately" millionaires who plague the industry. No wonder the public thinks of oil in terms of these few "braggarts."

•

These are big reasons why the oil industry, although it has done as much or more than any other industry for the American public, can find so few friends when the chips are down. This is the glaring paradox.

This absurd situation can be changed with but little effort. In fact, some—too few—oil companies have already pulled their heads out of the sands of conservatism.

An excellent example is Tidewater Oil's policy of showing the budgeted price for wildcats when they are announced to the press. Another is Imperial Oil's audio-visual program which gives the true facts about the company—and the industry—to each employe.

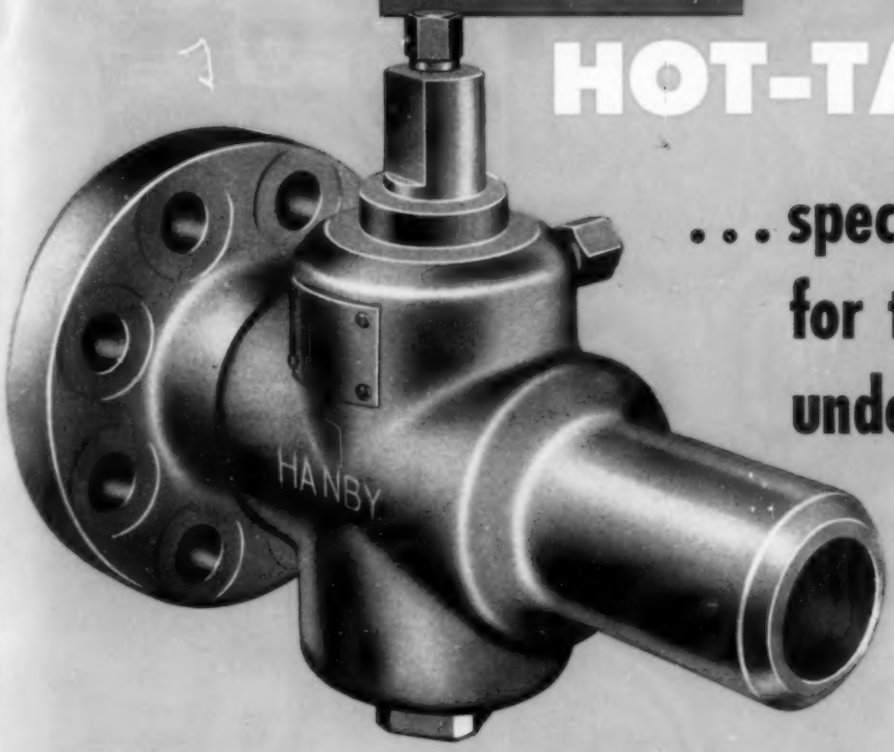
As Imperial demonstrates, publicity alone will not create public favor. Every employe in the industry must be an *informed* ambassador of good will.

These are examples that might well be followed by the entire industry. But these are not enough, many new examples must be created. Opening all doors to the public and telling oil's story to people outside the industry ranks would be good places to start.

Those who know us best will like us best.

The oil industry has a great story to tell. Let's tell it to the public—to employes—to dealers—to every individual who will listen.

This NEW HANBY HOT-TAP VALVE



. . . specifically designed for tapping gas lines under pressure

GAS TRANSMISSION COMPANIES have been asking for a valve that is *specifically designed* for use in tapping gas lines under pressure . . . and *HERE IT IS.*

BODY . . . is a solid, one-piece forging with no bonnet to leak or bonnet bolts to corrode.

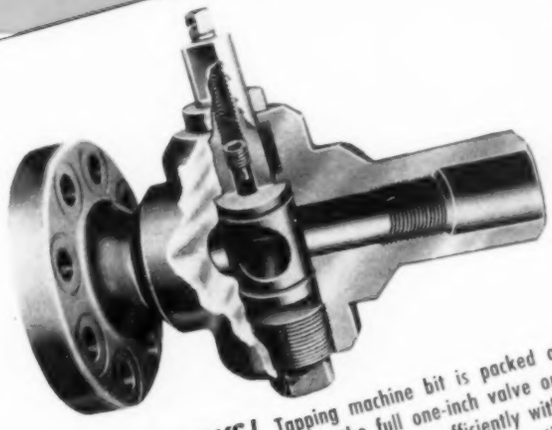
WELD-NIPPLE . . . of 2" diameter, in any desired length, is regularly furnished with 1" female internal threading two inches from the weld-end.

PLUG AND STEM . . . are of one-piece construction.

STUFFING BOX . . . is fully enclosed as part of the body and can be readily re-packed by inserting plastic packing through a removable set screw in the side.

In Addition . . .

. . . to hot-tap applications, this is an excellent blow-down valve for scrubbers and drips or low places in the line. Internal threading permits the use of a 1" syphon to the bottom of the pipe.



HOW IT WORKS! Tapping machine bit is packed off at flanged end and applied through the full one-inch valve opening and welding nipple. When tap is made, bit is sufficiently withdrawn to permit valve closure as shown by cross-section. Connections are then completed and valve re-opened.

Ask an "Oilwell" Specialist in Pipe Line Equipment to show you this Hanby Valve . . . or write for full information.

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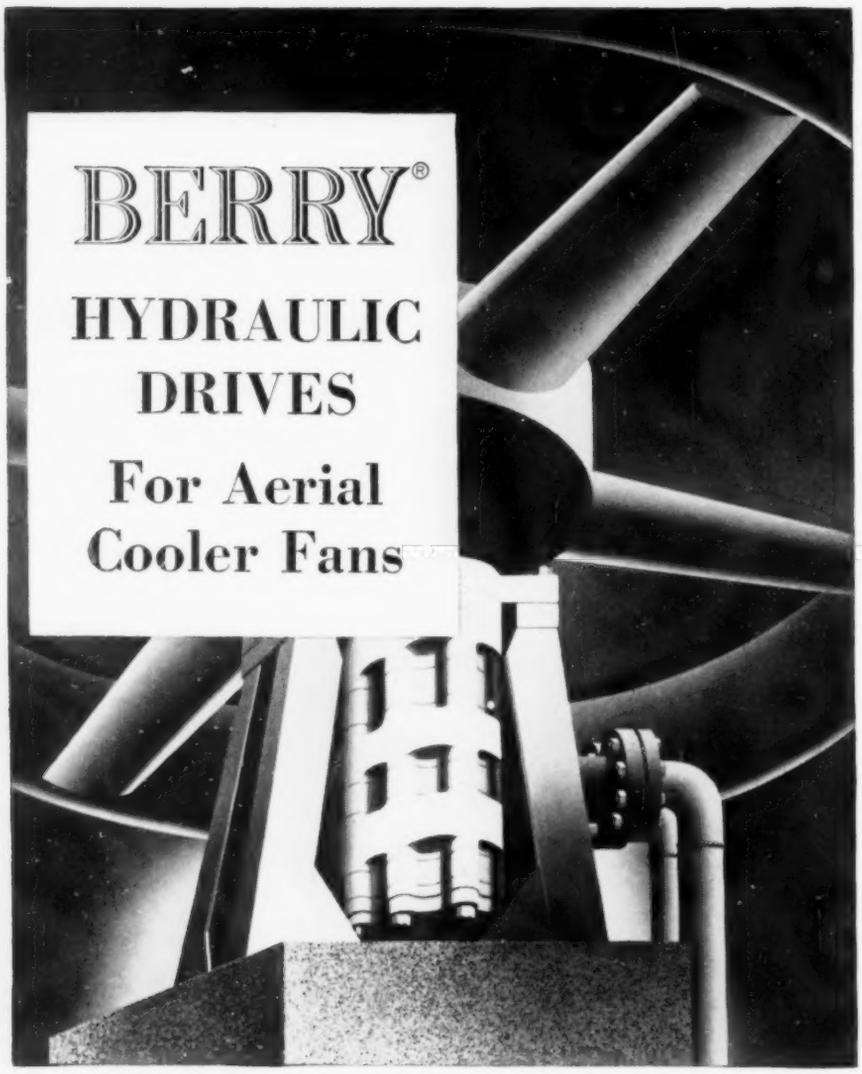

CHECK THESE ADVANTAGES

constant water temperature • The Berry drive makes it possible to maintain a predetermined jacket-water temperature accurately and automatically.

safe • The Berry hydraulic system has the safety necessary for gas transmission equipment and can be located in compressor building at point of use.

simple, trouble-free • Fan may be mounted directly on Berry hydraulic motor shafts, and the pump may be direct or belt driven from compressor flywheel.

saves power • With the Berry hydraulic drive, horsepower used to drive fan is proportionate to the cube of the speed of the fan. Whereas with a mechanical drive, the horsepower remains constant.

complete • System may be designed to integrate compressor and auxiliaries into a packaged unit. Compressor unit may be moved from location to location as needs increase or decrease, without interrupting station operation.

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low overall investment • The integrated hydraulic drive, powered from compressor, eliminates hazardous electrical equipment and additional buildings necessary.

fully automatic • When untended service is a "must," Berry drives can be integrated with other controls to provide automatic compressor stations.

See how Berry fills your needs.

Write for this 8-page bulletin which gives full data on Berry pump/motor "package" units.

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OLIVER IRON AND STEEL CORPORATION

PITTSBURGH 22, PA.

PIPE LINE INDUSTRY

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WORLD OIL and **THE COMPOSITE CATALOG** for the drilling-producing-pipe line industry.

PETROLEUM REFINER and **THE REFINERY CATALOG** for the refining-natural gasoline-petrochemical industry.

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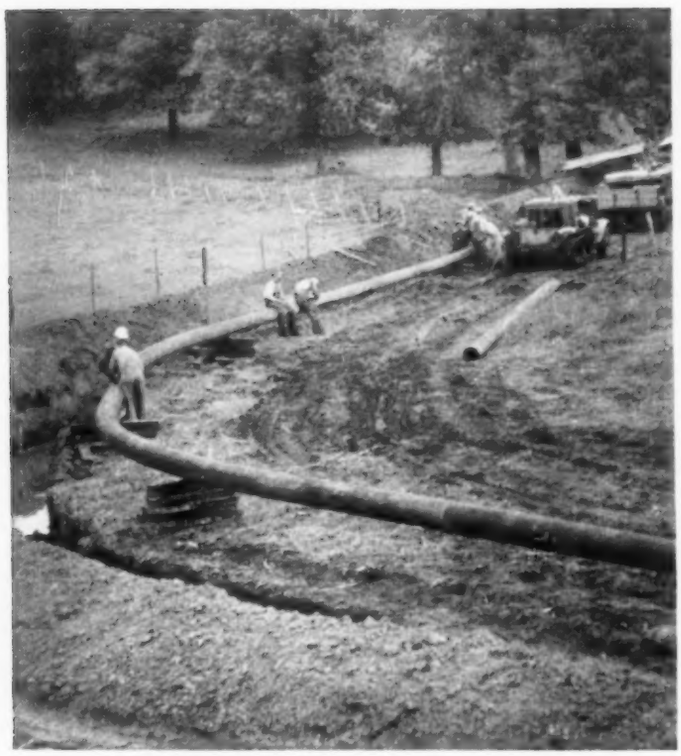
Youngstown

OFFERS THE "BIG 5" IN ELECTRIC WELD LINE PIPE FOR OIL AND GAS PRODUCING AREAS. . .PROVEN AND READY FOR EFFICIENT SERVICE IN THE FIELD



Here are the "Big 5" reasons why Youngstown Electric Weld Line Pipe is your best buy:

1. It bends readily
2. Wall thickness is uniform
3. Line up characteristics are excellent
4. Weldability is outstanding
5. Long lengths save you time and trouble

Terrain dictates some mighty peculiar contours. As an oil or a gas man, you're well aware of this. But, are you also aware of the secret of bendability of line pipe? It's simply the right combination of physical and chemical properties. Youngstown Electric Weld line pipe manufactured from uniform high quality steel, is capable of producing even smooth bends to fit any contour with uniform roundness. You know the importance of this—you know what this means on any job.

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Youngstown

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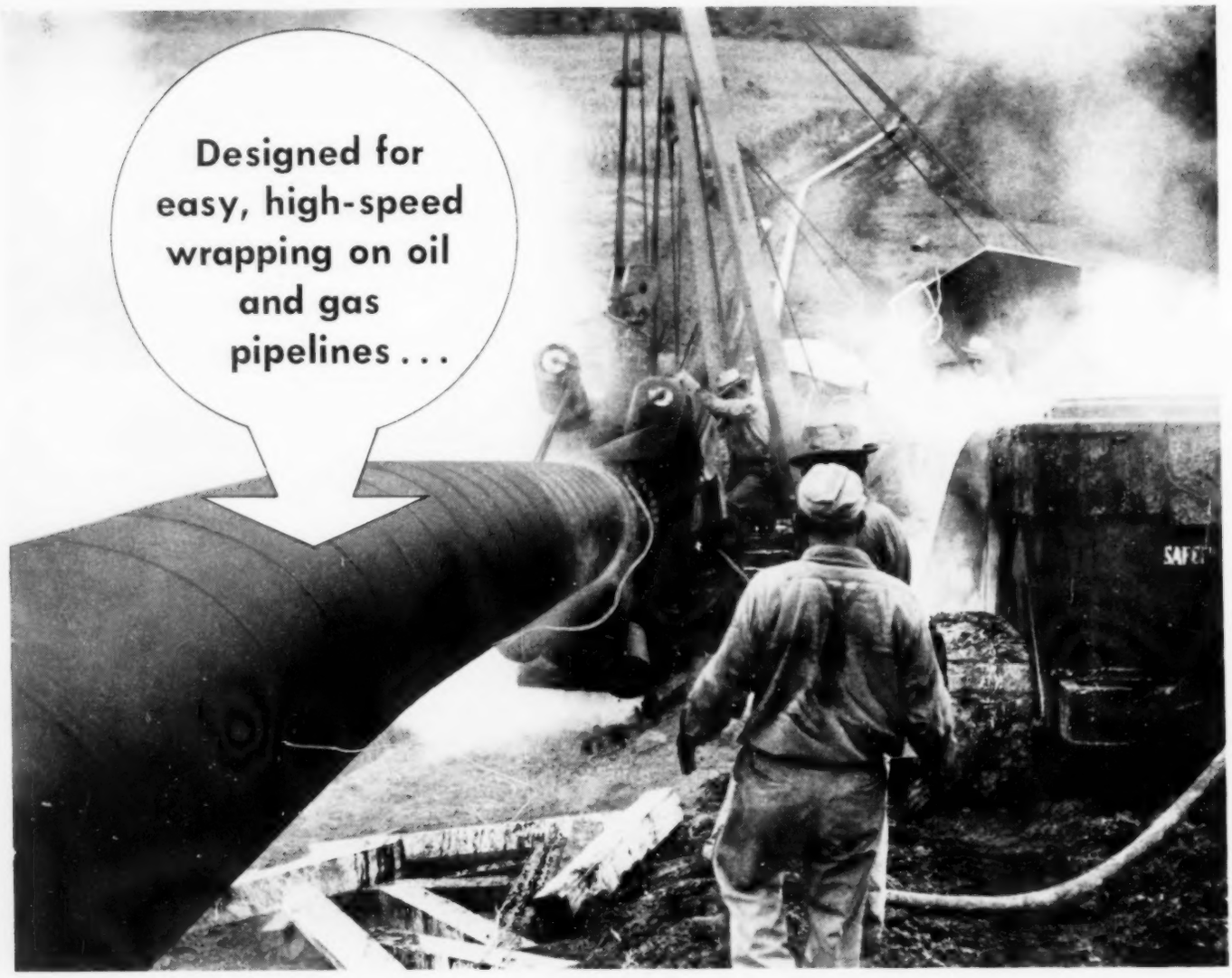

Johns-Manville TRANSHIELD® ASBESTOS PIPE LINE FELT

goes on fast, restricts soil stress, cuts maintenance

ON job after job, pipe line men have found that Transhield Asbestos Pipe Line Felt meets the need for an economical asbestos shield that is effective in average soil conditions.

Contractors like Transhield because its special reinforcement makes it ideal for easy, high-speed application by modern machine methods. Consisting of a lightweight coal-tar-saturated asbestos felt, it is reinforced with continuous glass yarns parallel-spaced on ¼" centers. Transhield's light weight permits the use of 800-ft. rolls which increases application speeds since fewer stops for roll changes are required.

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For further information write to Johns-Manville, Box 60, New York 16, N. Y.; in Canada, 565 Lakeshore Road East, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS **Johns-Manville PRODUCTS FOR PIPE LINE PROTECTION**

MAINSTAYS of PRODUCTION

wherever the spread runs!

In terrain like this, east of Plevna, Montana, production averaged three miles a day. O. R. Burden Construction Corp., Tulsa, Oklahoma, used an equipment line-up that was predominantly Caterpillar for money-making performance.

Along with these two CAT* MD6 Pipelayers on this spread east of Plevna, Montana, the O. R. Burden Construction Corp. relied heavily on other Caterpillar equipment for profitable production. Included in its line-up here were the following big yellow units: three D8 Tractors, four D7 Tractors, one MD7 Pipelayer, two D13000 Engines in Cleveland ditchers and a No. 12 Motor Grader.

You'll find that concentrating on Caterpillar equipment pays off *three* ways:

1 Every unit, from pipelayer to motor grader, is ruggedly constructed to stand up under the beating of pipeline construction. The MD6, for instance, has an exclusive oil-type clutch that seldom requires adjustment and lasts much longer than ordinary clutches. And its bellows sealed track rollers keep mud and dust out for longer life. These, and other Caterpillar-developed features, enable it to do *more* work at *lower* cost with *less* down time on any job.

2 Familiarity with Caterpillar's simply designed engines enables your mechanics and grease crews to handle maintenance routine with a minimum of time.

3 The network of Caterpillar Dealers makes it easy for you to handle your replacement parts problems wherever you are. Here's word from Burden's Spread Superintendent C. M. Hoffman about this: "Wherever our spread runs, we find Caterpillar Dealer service ready and willing to keep our Cat equipment in top operating condition."

What's more, you'll find the latest developments in pipeline equipment *first* at your Caterpillar Dealer. One example: the all-new 190 HP No. 583 Pipelayer —the first complete pipelaying unit, with a lifting capacity of 130,000 pounds maximum. For complete information on the rugged yellow line, see him today.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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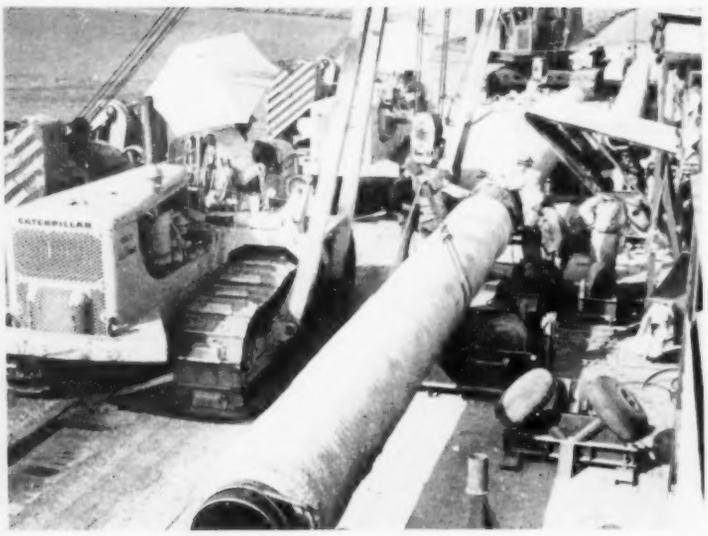
USE CAT EQUIPMENT FOR MONEY-MAKING PRODUCTION



1. Sideboom tractors move joints of 24-inch, 0.406-inch wall pipe to one of three double jointing stations. After weld is completed, the double-joint may be either rolled forward on the second pipeway or picked up and moved by the two tractors.

2. Welders on Williams Brothers barge double joint 40-foot sections of pipe. Twelve welders working at three double-jointing stations and three launchway stations make possible an average output of 85 to 90 joints per 12-hour day.

Longest Underwater Pipe Line Nears Completion

Contractors met new problems every day on TGT's 'Muskrat Line'. Here is how they solved them to lay the 355-mile line in record time.

By **MELVIN A. JUDAH,** Editor,
PIPE LINE INDUSTRY

PIPE LAYING on Tennessee Gas Transmission Company's Louisiana coastal line closely resembles a well coordinated combat operation. Contractors who have stretched pipe lines across every other kind of terrain around the world are wading through South Louisiana's marshes and bays using a batch of ingenious methods.

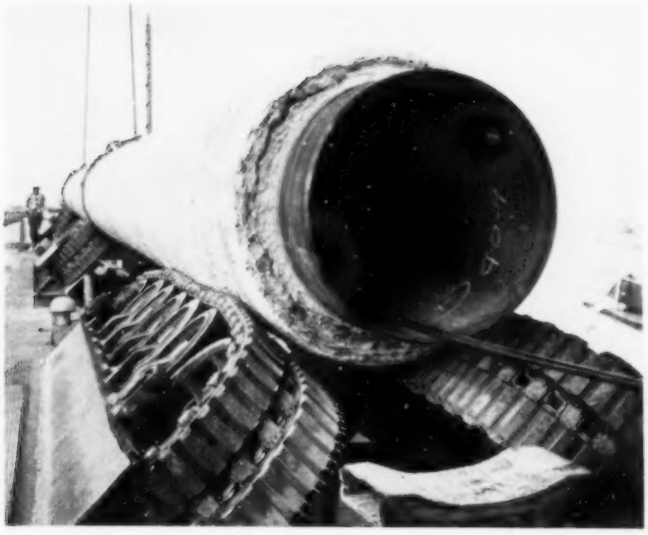
Every means of transportation is used. Spreads have their own "navy" and "air force," but the workhorse is the reliable lay barge with some new additions. A variety of boats and barges can be seen along the marsh right-of-way. River quarterboats house construction crews. Airplanes shuttle engineers, inspectors, and other personnel out to the job, saving hours of driving and boating from one location to another on the 355-mile line. Survey crews used helicopters in laying out much of the right-of-way. It isn't unusual to see two or three float planes or amphibians making a landing in a barge canal practically in a traffic pattern.

Williams Brothers, Houston Contracting Company, Sharman, Allen, Gay, & Taylor, Inc., and Collins Construction Company completed the 285-miles of underwater line by a variety of construction methods. A Grayco Constructors, Inc. spread laid a section on the western end of the line earlier using conventional land methods.

A tandem barge, 400 feet long, with three pipeways, enabled Williams Brothers to launch 85 to 90 joints per 12-hour day, using 12 welders at six stations. On the inboard pipeway, six joints of pipe are double jointed at three welding stations. From there the double-joints are lifted to a storage and transfer way. As the barge moves forward, a crane lifts the double-joint to the forward station of the launching way for line up and stringer bead weld. Filler welds are finished at two more stations and the field joint is wrapped and concrete coated before a winch pulls the pipe into the water astern.

Mississippi River Crossing Pulled in a Catenary. Collins used the continuous marine traffic method to cross the Mississippi river at two points south of New Orleans. TGT's 24-inch 3200-foot crossing near Buras, Louisiana, was pulled in a catenary on the river bottom. This is the first such crossing pulled underwater by Collins' patented method. A barge near midstream guided the tow cable movement, pulling the line on a 14-degree downstream leg near each bank. These approaches are tangent to a large radius curve at mid-stream. Although the pipe was buried by jetting it into the river bottom, the catenary design provides for maximum strength against possible future shifts in the bottom.

Marsh Right-of-Way Presents Unique Problems. Right-of-way



3. A double-joint is placed on the V-shaped rubber track launchway ready for line-up. Unique design facilitates line-up and stringer bead welding. Extra heavy 4-inch concrete coating gives pipe a negative buoyancy of 95 pounds per foot for river and bay pass crossings where current is swift.

4. After the field joint is wrapped with polyvinylchloride tape and reinforced with wire mesh, a laminated plywood-waterproof paper form is banded around it. Concrete is then poured into the form and it is covered and banded for launching astern. Two field joints are coated simultaneously.

5. Gasoline-engine powered winch pulls pipe off astern of Williams Brothers barge after each double-joint weld and field joint is completed. At a rate of 3500 to 4000 feet per 12-hour day, the spud barge moves ahead about every 15 minutes.

agreements in much of the marsh country require that the pipe line lay canal be dammed off from crossing waterways to prevent influx of salt water or possible damage to landowners' property after the line is buried. To eliminate this possibility, TGT is building nearly 170 such bulkheads at intersecting canals.

Concrete coating provides the correct weight to keep the line buried. Platforms were constructed to make sure that main line valves, scraper traps, blowdowns, and tie-ins will always be accessible by boat or aircraft. Concrete coating for the 24-inch line varied in thickness from 1½-inch up to 4 inches for passes and bay crossings. Concrete was applied by Rosson-Richards Company, Anchor Wate Company, H. C. Price Company, and Pro-Tekto-Kote.

6. Food on the Williams Brothers quarter-boat was good, too. Shown here a few minutes after landing for lunch are, clockwise around table, R. E. Woodson of J. Ray McDermott, Inc., pilot; Robert Johnson, TGT pilot; George Littlejohn, Williams Brothers engineer; A. C. Poulk, TGT pipe line construction superintendent; and, with back to camera, Leonard Robinson, TGT chief inspector; H. B. McDowell, TGT division superintendent; and Dick Titus, PIPE LINE INDUSTRY associate editor.

Continued on Next Page

7. S. V. (Sammy) Collins gives pulling orders to winch stations on each side of the Mississippi River by two-way radio. Pipe moving up the shore launchway in the background went into the river at a rate of about 40 feet per minute. This 3200-foot crossing is first one completed on a catenary using Collins' continuous marine traffic method.

8. One the launchway east of the Mississippi, a 1600-foot section of 24-inch pipe is ready for the pull. Rubber-tired dollies support the string. Near the top of the levee in the foreground, a "monkey-motion" carrier gives the pipe the proper overbend.

11. Holdback winch anchored 1700 feet back from the river's east bank levee maintains the correct back tension on the pipe during the pull. A force of 18,000 pounds was preset on the torque converter at the winch control panel. As the pipe section moved across, readings on the dynamometer checked the tension to make sure the pipe was under positive control throughout the pulling operation.

12. Final weld is made on Mississippi river crossing as Collins welders tie-in second 1600-foot section for pull. Nearly 30 pounds of welding rod was required to make each weld in the 0.937-inch wall pipe. Field joints were then wrapped with polyvinylchloride tape and coated with 1½-inch concrete. Pontoons buoyed pipe giving it a negative buoyancy of 4 pounds per foot in the river.

a catenary along the river bottom . . .

9. Another 'monkey motion' carrier mounted on a barge completes the overbend support. Rubber-tired guides on pontoon lead pipe into the water at proper angle. Crane on barge near midstream positioned pulling cable to keep the line in a catenary on the bottom. Crossing was laid on a 14-degree angle downstream from each bank tangent to a large radius arc in midstream. TGT's amphibian taxies over the line for take-off.

10. Rivermaster winch on the west bank levee pulls the pipe under the river. A force of 36,000 pounds pulled the pipe at rate of 35 to 40 feet per minute. Winch is anchored to piling and deadman behind levee.

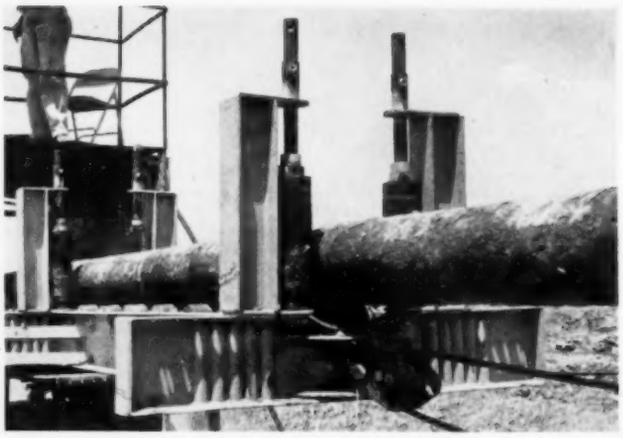
13. Pull is completed. Ship passes over line in channel soon after the towing head came out of the water on the west bank of the Mississippi river. The 3200-foot crossing was pulled in one day, after tow cable was laid and pipe sections welded. Fathometer surveys show the pipe to have a maximum deflection of less than two feet from any point on the catenary.

14. Pontoons pop to the surface after being released from the pipe by a trip cable. The 24-inch heavy wall, concrete coated pipe, weighing 120 pounds per foot in water, then settles into the river bottom. It was later buried to a depth of 12 feet by Collins' jet-trenching machine.

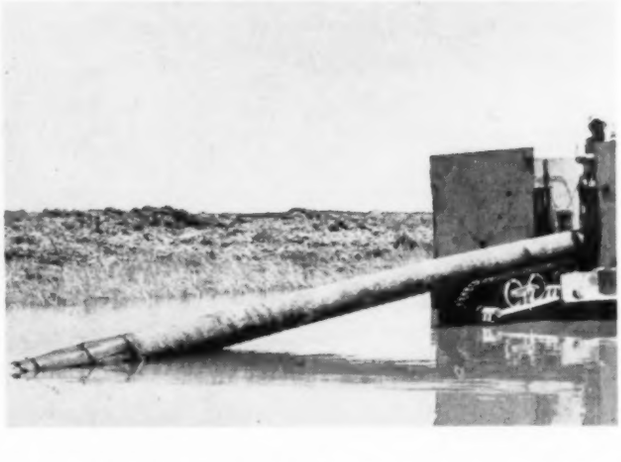
Continued on Next Page

Methods of laying supply laterals similar to those on Big-Inch barge work . . .

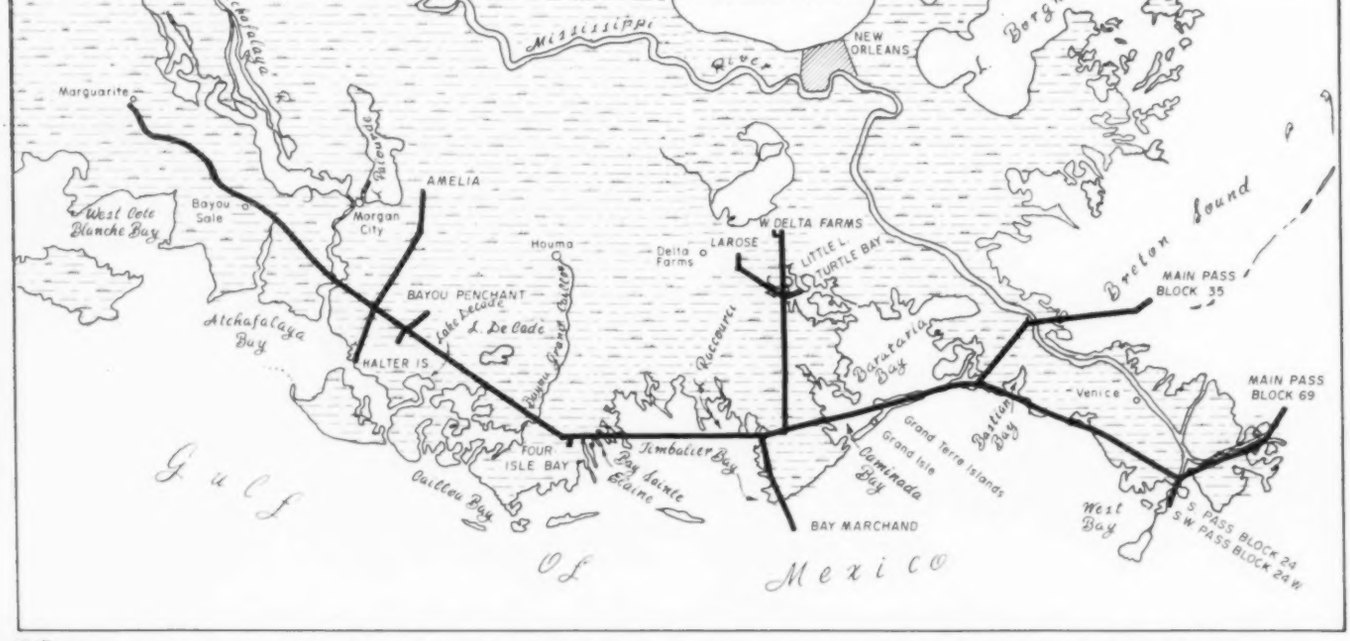
15. A joint of 8-inch pipe is washed down and placed on rollers for line-up on Sharman, Allen, Gay and Taylor's barge. This supply lateral from Block 35 Breton Sound will tie into TGT's main 24-inch line just east of the Mississippi river.



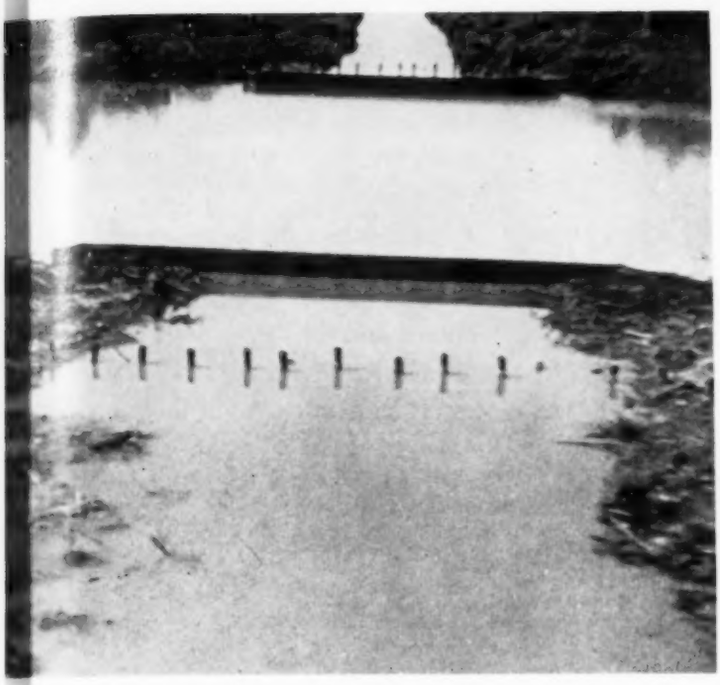
16. Rollers set at right angles adjust to fit various sizes of pipe. On the 'Muskrat Line,' where pipe diameters ranged from 6 to 24-inch, versatility of equipment was an important factor in construction. Here a joint of 8-inch is ready to be pulled off astern of Sharman, Allen, Gay and Taylor's barge. Pulling cable under pipe leads to winch forward on the barge.



17. Rubber tracks support pipe as it is lowered off barge into flotation canal. Field joints were wrapped with polyvinylchloride tape; then concrete coating poured inside pressure treated mastic form. Forms were covered and strapped to protect the fresh concrete as it entered the water. A 1-inch coating of 140 pounds per cubic foot concrete gave the pipe needed weight and protects against marine growth.



18. Southern section of TGT's Louisiana Coastal Line dubbed the 'Muskrat Line' for reasons readily obvious to contractors who laid it.



19. Some 175 bulkheads will be built at intersecting bays and bayous to prevent salt-water influx into flotation barge canals used in laying the line. At this crossing of the Intercoastal canal, 40-foot piling was driven 30 feet into the marsh to support 2 by 8-inch whalers. Additional piling and guy cables add strength. Earth fill was also used over piling at many canal crossings. The Muskrat Line crosses more than 130 navigable waterways.

20. Main line valves, scraper traps, tie-ins, and blow-downs were built on platforms above the marsh. Main Line Valve No. 521 at Bayou Penchant is typical. Pressure creosoted piling was driven into the marsh 40 feet below water to withstand possible hurricanes. Valves and fittings are coated with a coal tar-epoxy resin material for protection against the corrosive atmosphere.

21. Houston Contracting makes tie-in at Main Line Valve Platform 523. Pipe is offset at 45-degree angle so the canal is still clear for work barges. Crane lowers prefabricated joint into position for welding. As soon as the completed section is pigged, the valve will be lifted onto the platform and installed.

22. Valve platform completed. A section of line upstream from this main line valve is being blown down. Automatic operators will be installed after line is put in service. Concrete coating extends 3 feet above normal marsh level for protection against boats and splash area. All above water valves and fittings are protected against corrosion by a coal tar-epoxy resin coating.

—The End

AGA research promises . . .

More Accurate Flow Efficiency Tests Ahead

Four-year program spotlights need for accurate field measurements, uniform data records and a critical evaluation of the results.

By R. F. BUKACEK and REX T. ELLINGTON
Institute of Gas Technology, Chicago

EVALUATION OF the capacity of gas pipe line systems is getting a great deal of attention with the record expansions of the past few years. Construction and operating costs have risen with the larger quantities of gas transported. Economical operation demands high flow efficiency.

Viewpoints of individual companies regarding the importance of efficiency tests differ. All are concerned with capacity from one or more aspects.

1. Serious reduction in the capacity of pipe line systems operating near full loading must be prevented.

2. The ability to predict accurately the effect of incremental loads in the operation of existing facilities is important.

3. Improvement of pipe line performance yields important savings in operating costs when compression costs are large.

4. Design factors for sizing pipe line system additions should be based on the performance characteristics of existing lines.

To evaluate pipe line performance, valid efficiency test data are needed. Various techniques for pipe line flow efficiency testing have been developed to obtain it. With the growing interest in efficiency testing there has been a need for evaluation of the techniques of most general utility, the calculations and equations to be used, and the reliability of test data.

In 1954 the Institute of Gas Technology developed a set of preliminary recommendations for pipe line efficiency testing which formed the basis for "Pipe Line Efficiency Test Procedures," Project NB-13, sponsored in 1955 by the Pipe Line Research Committee of the American Gas Association. The procedures are based on observation of field tests, analysis of test data and consultation with cooperating pipe line companies.

What procedures and equipment are used? The flow efficiency of a pipe line section is the ratio of the measured flow to that calculated by use of a flow equation for the same operating conditions. Field measurements required to determine flow efficiency are flow rate, pressures, temperatures, and specific gravity of the gas, the elevation change between the ends of the section under test, and atmospheric pressures.

Required equipment includes calibrated deadweight gages, two temperature-compensated aneroid barometers, thermometers, a gas gravity balance and such accessory fittings, tubing and communications gear as circumstances require. Equipment needed for flow determination varies according to the technique used.

Pipe line conditions must be stabilized for valid results. Since all equations presently used for estimating the rate of gas flow in a pipe line apply only to steady state operation, it is necessary that pipe line conditions be stabilized for the tests to yield valid results. Therefore, the dispatcher should be briefed on the nature of the tests and the importance of pressure stability, and compressor station personnel should be properly instructed.

At shift changes where the new operating force finds pressures different from those of the pressure order, instructions should read, "Maintain the existing pressure rather than adjust to the order." Field personnel should be requested to correct abnormal line conditions which might affect the validity of the test; for example, drips should be blown to remove any unusual amounts of liquid that have accumulated.

Flow measurement made with orifice meter or tracers. The gas flow at the time of test is preferably determined by use of orifice meters. Where orifice metering is not practical, flow determination by use of a tracer is recommended.

The design of orifice meter installations and the calculations of natural gas flow rates from chart data are made in accordance with the American Gas Association's Gas Measurement Committee Report No. 3, "Orifice Metering of Natural Gas."[2]

Prior to test work the recording equipment is to be inspected and calibrations run on the static and differential pressure pens. The orifice plate should be inspected and, as far as possible, all conditions which would lead to inaccurate measurement should be recorded.

The use of orifice meters located far from the section of pipe line under test is recommended only when the period for flow and pressure stabilization is sufficient that the flow rate measured by the meter unquestionably corresponds to that in the test section. In most cases, it is not possible to obtain such stabilization when there is a takeoff or compressor sta-

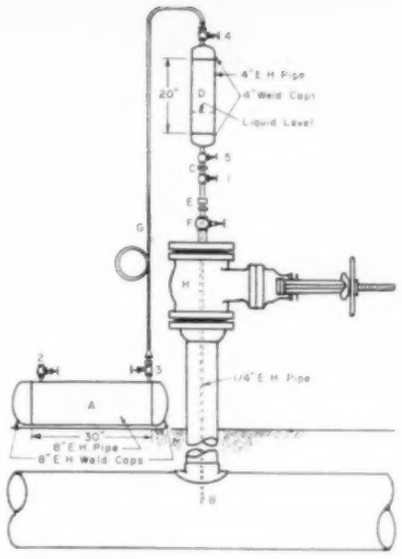
tion between the orifice meter installation and the test section.

Tracers give good results where orifice meters aren't available. Tracer techniques consist of injecting a small quantity of detectable material into a pipe line and measuring the elapsed time for its travel to a specific point downstream. The volumetric flow rate is calculated from the travel distance and time, nominal inside pipe diameter, and averaged conditions of gas temperature and pressure.

Sufficient line length must be chosen to reduce to acceptable limits errors in timing the tracer and in line length determination. The travel distance must be sufficiently short that dispersion of the tracer does not make its detection difficult. Experience has shown that 5- to 15-mile distances are quite satisfactory.

Anhydrous ammonia is commonly used as a tracer because of its low cost, availability, and ease of detection. Equipment required for its injection includes an ammonia storage cylinder; a high-pressure bottle, with a stainless steel valve at each end, to hold a 3- to 5-pound charge of ammonia; a stop watch; and auxiliary fittings and equipment.

A pressure tank injection method is illustrated in Figure 1. Entry into the pipe line is made through a blowoff riser. The pressure tank A (capacity: 1 to 2 cubic feet) is first filled to line pressure with gas from the riser, and is disconnected from the riser. A length of extra-heavy ¼-inch pipe is then inserted into the riser through a stuffing box. The pipe is fitted with a ¼-inch coupling stop B at the lower end, to prevent the pipe rising above the stuffing box in the event of a mishap, and a union C, and valve 1, at the upper end. This valve is left open during insertion of the pipe to reduce the force required to run the pipe in, and is closed when the stuffing box nut has been tightened and the pipe secured to the riser assembly. A rope or chain looped across valve 1 and around the riser valve body may be used to secure the pipe further. The high-pressure bottle, containing from three to five pounds of anhydrous ammonia, is attached to the pipe at the union. The amount of ammonia required depends upon the diameter of the line, travel distance, and the condition of the pipe line interior surface. While three to



A – Pressure Tank
B – 1/4" Coupling Stop
C – 1/4" Union
D – Ammonia Bottle
E – Stuffing Box
F – 1" Valve
G – Copper Tubing
H – Riser Valve

Numbers Refer To 1/4" Valves

FIGURE 1—Typical setup for injection of ammonia into pipe line through blowoff riser. Direct and rapid injection into main gas stream is essential to accurate timing of the tracer's travel.

five pounds of ammonia may be considered an average requirement, more may be needed in some cases.

The pressure in the tank is then increased to approximately 200 pounds per square inch above line pressure by the injection of water from a portable piston pump connected to valve 3. A small Bourdon gage may be attached to valve 2 for determination of the tank pressure. The outlet valve is closed, ¼-inch copper tubing is run from it to valve 4 and both valves are opened, admitting high-pressure gas to the space above the ammonia in the bottle.

Valve 1 is then opened, and the ammonia is injected upon the opening of valve 5. Valve 5 should be opened as rapidly as possible, and the stop watch started immediately. The instant at which the valve opens is usually apparent from the sound of the ammonia passing through it. These valves should be gate valves, to minimize the time required to empty the bottle. The pressure indicated at the pressure tank may be compared with that before the injection valve was opened to find whether the injection was successful.

In the above scheme, a cylinder of commercial high-pressure nitrogen (available at 2000 psi) may be substituted for the pressure tank. Any tap in the pipe line may be used for injection; however, for taps over an inch in diameter, ¼-inch pipe should be inserted through a stuffing box. In any case, direct and rapid injection into the main gas stream is essen-

About the Authors

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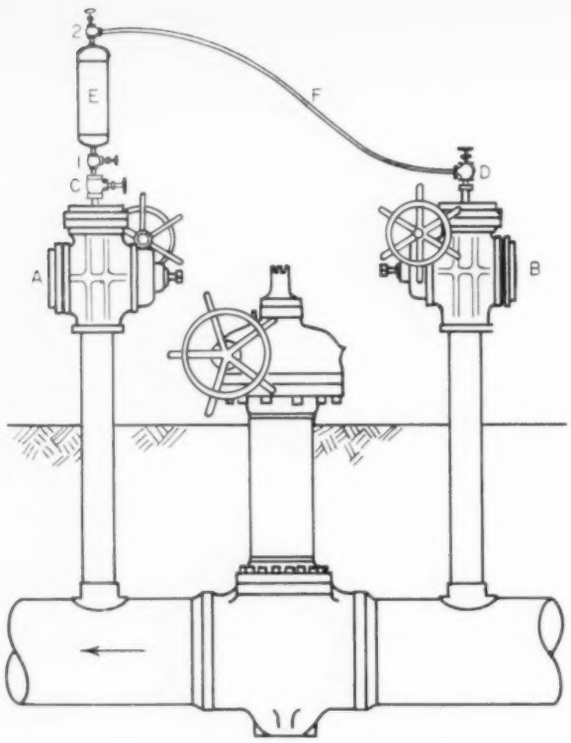

FIGURE 2—Line pressure may be used to inject ammonia into pipe line across blowoff risers. Pressure is admitted into ammonia bottle E by opening valves at 2, D and B. After valves C and 1 have been opened, ammonia is injected into the pipe line by opening valve A rapidly.

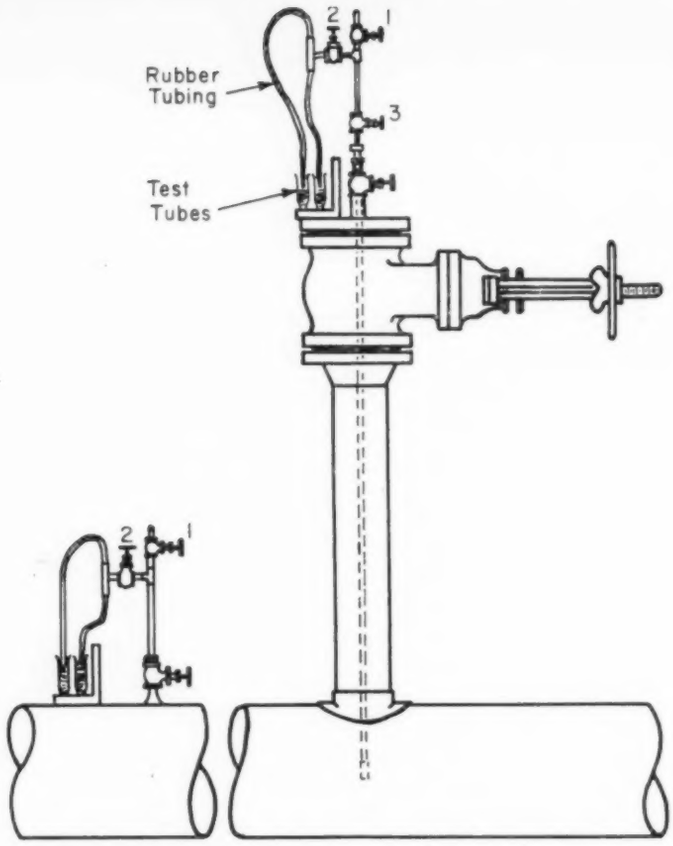

FIGURE 3—Ammonia is detected at a tap (left) and at a blowoff riser by allowing a moderate flow of gas into small test tubes of chemical indicator.

tial to accurate timing of the tracer's travel.

Simpler injection possible with line pressure. A second method of ammonia injection, applicable where blowoff risers are equipped with plug valves, is illustrated in Figure 2. In this method the downstream riser valve A is closed, and valve C is opened to blow down the space above. A holding bottle containing 3 to 5 pounds of anhydrous ammonia, is then attached to valve C with a short nipple (or adapter, if required). A length of ¼-inch copper tubing or hydraulic hose is run from valve 2 to valve D on the upstream blowoff riser, and line pressure is placed on the bottle when valves 2, D and B are opened. The contents of the bottle are driven into the riser top above the valve on the opening of valves C and 1.

Ammonia injection is accomplished by the rapid opening of valve A. The point at which the valve is cracked and flow begins must be previously determined and marked; the ammonia injection is timed from the moment this point is reached in the opening of the valve.

When the main line valve is at full-opening, it may be necessary to close this valve partially in order to get the ammonia into the pipe line as valve A is opened. The main line valve should be maintained in a pinched position for the least possible time; hence, the use of a pneumatic operator is highly desirable.

Accurate tracer flow rates depend on good detection downstream. Ammonia detection equipment is shown in Figure 3 as set up at a tap, or at a blowoff riser. It includes a manifold system consisting of ¼-inch pipe with tee connection and two ¼-inch valves, rubber tubing, several test tubes or small bottles for the chemical indicator, and auxiliary fittings as required for the detection location. If taps over an inch in diameter are used, ¼-inch pipe must be inserted through a stuffing box into the main gas stream, as described earlier.

To detect the ammonia, distilled water and a stock solution of phenolphthalein (1 gram of phenolphthalein dissolved in 50 cc of alcohol to which is added 50 cc of distilled water) are used. For an indicator, two drops of the stock solution are added to 30 cc of distilled water. This liquid is colorless, but turns pink in the presence of ammonia. Only distilled water should be used, since contaminants in fresh water may affect the sensitivity of the indicator.

Another chemical, methyl red, may be used in place of phenolphthalein. This stock solution is prepared by dissolving two grams of methyl red in one liter of alcohol. For an indicator two drops of the stock solution are added to 30 cc of distilled water. This solution is yellow, and a slight amount of acid must be added to it to obtain the red color required. However, no acid beyond the minimum necessary to produce the red color may be added, so a small amount of ammonia can change it back to yellow. Too much acid will keep the solution from changing color immediately on arrival of the ammonia.

Testing for arrival of ammonia downstream. With the manifold system installed as shown in Figure

3, a test tube (or small bottle) of the indicator is placed in a rack near the manifold, or is suspended from it by a short cord. The vent valve is then opened, venting gas to the atmosphere. A piece of rubber or plastic tubing is connected downstream of valve 2. The valve is opened slowly until a moderate flow of gas is passing through the tubing. The open end of the tubing is placed in the test tube, either just below the indicator surface, or very slightly above it, and the valve is adjusted to establish intimate contact between gas and indicator.

If the tubing is inserted in the indicator, the entire solution will change color at the same time; if it is suspended just above the indicator surface, and the valve is adjusted so that the solution is indented by the impinging gas stream, the surface will change color before the main body of liquid. The second method is extremely sensitive because only a very slight amount of ammonia is required to change the color of the surface layer of indicator. The first indication of color change is quickly noted at the time of ammonia arrival.

Accurate timing is simple, but important. Stop watches are used at both injection and detection points to time tracer travel. The starting watch may be transferred to the detection point if there is sufficient time or the starting time may be forwarded to the detection point by radio.

A common procedure in sending starting time is: "On the mark the time will be X minutes . . . 5-4-3-2-1-Mark" where X minutes have elapsed between the injection and "mark" time. At "mark" time the stop watch at the detection point is started; it is stopped when the indicator changes color. The time of tracer travel is that recorded at the detection point, plus the number of minutes between injection and mark time.

In the event that topography, atmospheric or other conditions make it impossible to relay the starting time to the detection point before the tracer arrives, the watch at the detection point is started on the tracer's arrival. As soon as it is possible to bring the two watches together they should be stopped simultaneously; the difference between their readings will be tracer travel time.

Check run should be made with tracers. In the use of the tracer technique at least two flow rate determinations should be made to verify the results. To reduce the time required for the check, the second slug of tracer is usually injected a relatively short time (perhaps 20 minutes) after the first. Under these circumstances the sample stream may contain slight concentrations of ammonia from the first injection, even at the time that the second slug arrives at the detection point. If so, the detector solution may undergo slow color change in the period prior to the arrival of the second slug. This difficulty can be overcome by splitting the sample gas stream and feeding it as separate streams into twin tubes of indicator. Solutions can be alternately replaced as they show color changes. Thus one of the streams will always be in contact with comparatively fresh indicator fluid. The very rapid and deep color change on arrival of the second slug can be readily distinguished from the slow color change previously noted.

Series of pressure readings should be recorded at 10-minute intervals. Pressure readings must be taken at the terminals of the line section under efficiency test and at the injection and detection points when a tracer is used to determine flow rate. In all cases a series of readings should be made and recorded at 10-minute intervals at each point to check line pressure stabilization. Where a tracer is used, pressure readings should be started at least a half hour before injection and continued through the period of tracer travel. Two-way radio communication enables coordination of the operations and comparison of the readings.

Measurements are to be made to the nearest 0.1 psi with calibrated deadweight gages. The weights belonging to each gage should be numbered consecutively, beginning with the largest weight. At all times, in calibration or field work, the addition of weights is to be made in numerical order. This procedure simplifies correction of pressure readings, as it eliminates the necessity of keeping a record of the weights used.

Pressure gages should be calibrated before test. As a minimum precaution, the gages should be calibrated with a deadweight tester, or against one of the gages chosen as standard. The following procedure is recommended for checking each gage against the standard. Gages are manifolded, No. 1 weights are placed on the gage platforms, and sufficient pressure is applied to bring one of the gages into balance. If the other is not in balance, sufficient weight is added to the gage showing the lowest reading to bring both gages into balance. This weight, if it has been added to the standard, becomes a positive correction, and a negative correction if added to the gage under test. This process is repeated with weights Nos. 1 and 2 on the platforms, then weights Nos. 1, 2 and 3, and so on until all of the available weights have been added. By this procedure the readings of all gages can be corrected to those of the standard. Good practice requires that the standard gage be calibrated periodically by the manufacturer.

Since absolute pressures are required in the calibration of efficiency, it is necessary to obtain barometric pressure measurements at the pressure measuring points. Atmospheric pressure variations due to changes in elevation and local weather conditions can be especially important for tests at small pressure drops.

Gas temperature measurements are not critical. Gas temperature measurements made by inserting a suitable thermometer into the gas stream are preferable. Mercury in glass thermometers should not be used, however, gas temperatures are ordinarily not critical to accurate determination of efficiency, and pipe wall temperatures obtained by attaching thermometer wells, thermocouples, or resistance thermometers to the pipe wall are very satisfactory. Where the pipe is accessible, a thermometer bulb held to the pipe wall with insulation and a paper wrap and covered with dirt will in many cases give sufficiently accurate results.

Pipe wall temperatures obtained by inserting a thermometer in a bar hole down to the pipe will be satisfactory only where good contact with the pipe wall is assured. Since ground temperatures may change rapidly over short distances from the pipe, the use of this method of obtaining temperatures should be avoided.

An alternative is to make use of above-ground crossover or valve bypass connections, arranging the valves to pass gas through the bypass or crossover, and reading the temperature from a thermometer inserted

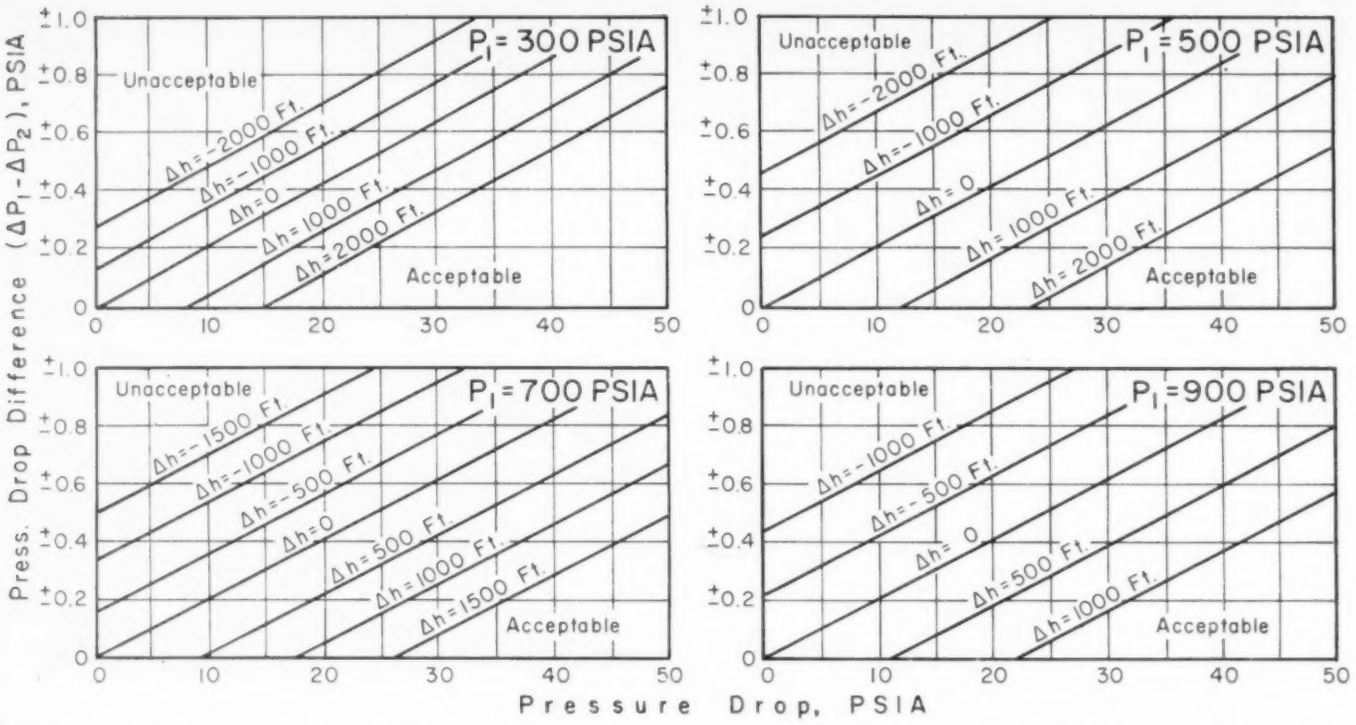

FIGURE 4—Pressure drop differential vs. pressure drop plots may be used to determine the stability of line conditions. The variation of pressure drop is acceptable if the intersection of the projections of these values lies below and to the right of the elevation change lines for section under test. It is unacceptable if they intersect above and to the left.

through a stuffing box into the bypass gas stream. This permits the use of short-stemmed thermometers, but requires a tap installation in the bypass or crossover connections. Recording or indicating thermometers should be calibrated in the field by use of a mercury in glass thermometer before each use.

Gas specific gravity should be measured at time of test. Where station gravitometers are located close enough to the test site, their readings may be used; however, where specific gravity changes occur frequently, or where an accurate station measurement is not available, a portable gravity balance should be used. Gas specific gravity can be affected by contaminants in the line and by gas processing and mixing; hence appreciable errors can result from failure to obtain a gravity measurement. For example, the use of 0.650 specific gravity in place of 0.637 will result in a change of 1 percent in the calculated flow, and in addition may cause error in the supercompressibility factor determination.

Compressibility factor determination may be taken from AGA data. The most accurate method of determining compressibility factors is the direct measurement, with a Bean or Burnett apparatus,[1] of a gas sample taken at the time of test. However, ordinarily it is more convenient to make use of a suitable correlation of compressibility factor. The American Gas Association's "Supercompressibility Factors for Natural Gas" (1955),[3] and "Orifice Metering of Natural Gas" (1955),[2] present correlations of supercompressibility factors, $F_{pv} = \sqrt{1/z}$ (z is the compressibility factor), that are admirably suited to efficiency test use. These correlations require gas specific gravity, carbon dioxide and nitrogen content, or gas specific gravity, heating value and carbon dioxide content.

Elevation changes best determined by land survey. Where land survey is not practical and accurate elevation data are not available, an alternative is to use aneroid barometers calibrated to show elevation above sea level. Elevations determined by barometer are subject to instrument errors and variations in atmospheric pressure, but the effect of the latter can be minimized by adjusting two barometers to read together at the same point and time. A series of barometer readings is then taken simultaneously, over a period of approximately a half hour, at the ends of the section for which the elevation change is to be determined. Although atmospheric pressure may be rising or falling, it may be found that the difference between the readings is fairly stable.

How is line stability determined? Since the flowing fluid is compressible, it is not possible to develop a simple, precise mathematical relationship which can be used to determine the stability of flow required in pipe line efficiency test work. It is possible, however, to establish practical indices of line stability which suffice for most conditions encountered. These techniques have their limitations, however, and are not equally useful in all cases.

Generally speaking, constancy of flow rate and pressures at various points along the pipe line will indicate stable conditions within the line. However, both the pressure at a given point and flow rate will ordinarily vary under the best conditions that will be encountered. The problem, therefore, is to determine the variations in these quantities that can be tolerated.

Where orifice meters are used to measure flow rate, constancy of static differential pen readings is indicative of line stability at that point. If it is necessary to remove or add a con-

iderable quantity of line pack gas o obtain the desired test conditions, onstancy of flow and pressure at the nlet or outlet of the test section may ndicate a degree of line stability that s not true for the test section as a whole. Therefore, it is usually desirable, even when orifice metering is employed, to check the constancy of line pressures at several points within the test section.

The pressure at a given point is a much less sensitive index of line stability than the difference in pressure between two points. Variation in pressure differential is usually an excellent index of line stability.

From pressure measurements obtained over a period of at least 45 minutes, pressure drops over a line section are calculated for each pair of upstream and downstream pressures. From these, the variation in pressure drop is determined.

The significance of these variations is seen in Figure 4. The variation in pressure drop is acceptable if the point of intersection of the projection of average pressure drop and variation lies to the right of the elevation change line for the pipe line section tested; it is unacceptable if to the left.

Where the observed upstream pressure differs from those given in Figure 4, it is necessary to interpolate between the two pressures nearest to the observed pressure.

Where test section terminal pressures are controlled, as at compressor stations, they should not be used as a guide to line stability at the beginning of the stabilization period. Pressure drops over an interior section between the pressure control points, an ammonia test section for example, should be used.

For a given variation in pressure difference, pipe line flow stability is more assured at large pressure drops than at small ones. This suggests the desirability of making routine efficiency tests over as great a distance as is practicable. This procedure makes it necessary to obtain temperature profiles; however, the additional work involved is more than compensated by the increased accuracy obtainable with respect to flow stability and elevation change effects, and has the additional advantage that a minimum of time and money is expended in testing a long pipe line system.

Where flow rate determination is made by a tracer technique, a 5- to 15-mile interval within the section under test is used for the tracer travel; district personnel may be used to take the pressure and temperature readings at the test section terminals, and the additional temperature readings required for the temperature profile.

Where station-to-station efficiency tests are made, Figure 4 should not be extrapolated to the larger pressure drop values. The pressure variation in this case should be kept to a minimum, no more than 2 psi per hour at the terminals of the test section.

PIPELINE EFFICIENCY TEST Sheet of
Flow Rate Determination Data
Test Identification
Party Date
Injection Point Location
Detection Point Mile Post
Pipeline Diam Mile Post
First Ammonia Injected Ammonia Travel Distance
AM
PM Detected
Elapsed time to relay of starting time AM PM
Stop watch reading at detection point
Travel time
Second Ammonia Injected
AM
PM Detected
Elapsed time to relay of starting time AM PM
Stop watch reading at detection point
Travel time
Deadweight Gage No.
Time | Gage Press | Gas Temp | Atm Press | Comments

Flow test data sheets such as this serve as check lists for field crews and provide permanent record for calculations.

Field data forms reduce chances of errors. All data taken in the field during pipe line efficiency testing should be recorded on suitable forms. They provide a check list during the test and a complete record for later calculations. Field personnel who may not be familiar with test procedures will find them especially helpful. Since gas flow is often calculated in field work, the formula for determining flow rate from tracer data is often included.

Pipe line efficiency calculations are key to good results. The flow efficiency of a pipe line is defined:

$$E = \frac{Q_b \text{ (observed)}}{Q_b \text{ (calculated)}} \quad \text{[Eq. 1]}$$

where Q_b (observed) is the flow rate measured by orifice meter or tracer determination; and Q_b (calculated) is the value of flow rate calculated, by use of a pipe line flow equation, from the conditions prevailing at the time the flow rate measurement is made.

Several flow equations have been used to calculate flow rate; a general equation, the Weymouth formula, and the Panhandle *A* equation. The new revised Panhandle equation may also be used with good success especially where flow rates vary. These equations may include the compressibility factor, although they are sometimes used without it.

REFERENCES

[1] Bloomer, O. T., *Measurement of Gas Law Deviations with Bean and Burnett Apparatus*, Institute of Gas Technology Research Bulletin No. 13 (1952) May.

[2] *Orifice Metering of Natural Gas*, Gas Measurement Committee Report No. 3, American Gas Association, New York: the Association, 1955 (April).

[3] *Supercompressibility Factors for Natural Gas*, 7 volumes, New York: American Gas Association, 1955 (June).

ACKNOWLEDGMENT

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Flow efficiency testing of gas pipe lines gets 'going over' by this panel of industry leaders at the Eleventh Annual Short Course in Gas Technology. Pictured left to right are R. F. Bukacek, Institute of Gas Technology; Earl Humble, Texas Eastern Transmission Corporation; Jack N. White, Panhandle Eastern Pipe Line Company; J. M. Phillips, Southern Natural Gas Company; and panel moderator Sy Orlofsky, Gulf Interstate Gas Company.

What Engineers Are Asking About Flow Testing

Over 200 attended the Eleventh Annual Short Course in Gas Technology at Texas A.&I. Here are the important questions they asked—with the answers given by a panel of industry leaders.

GAS PIPE LINE FLOW efficiency gets more and more attention as rising operating costs demand maximum capacity of existing and proposed facilities. With an eye to improving their own efficiency testing methods, engineers at the short course put their questions to industry leaders on the panel. Their comments reflect what has been learned from AGA research and several years of field operating experience using various testing procedures.

Q. *What experiences have other companies had with efficiency tests?*

WHITE: There are several ways that testing is being done in the industry. Each of us thinks he has found the best answer based upon our own experience, but we need to take a good look at what others are doing. Perhaps the greatest need is for standardization of methods.

The most accepted method of measurement is with the orifice meter. However, orifice meters are not always available on every section of line where you want to determine the efficiency, so some other method of measurement has to be used.

We used the portable pitot tube in our early work in determining the flow rate for efficiencies. However, results were quite unpredictable, and installation of the pitot tubes was rather costly. After some experiments we decided to use ammonia as a tracer and detect it with methyl red in alcohol.

We first tried methyl red on filter paper and then in test tubes through which the gas was bubbled. We now have standardized on a solution of one percent phenolphthalein in 25 to 35 cc. of distilled water. Gas is bubbled through the colorless solution, and, when the alkaline ammonia arrives, the solution turns pink.

Stop watches are used to time the movement of the slug. Time checks between two test locations are coordinated by radio. Estimated travel time for the slug is calculated ahead of time and we usually start testing for ammonia five minutes early. Once the time of movement of the slug is known it is simple to calculate the flow rate.

HUMBLE: Our procedure differs somewhat from that of others on the panel in one respect. To obtain actual volume, we use main line check meters. We are fortunate in having them at strategic locations on our system.

Q. *How do flow measurements with ammonia tracer compare with orifice meter measurements?*

BUKACEK: In a field test with Panhandle Eastern last year, we found that they compare very closely. For example, on tracer travel distances of from 4 to 20 miles, the difference between tracer and orifice meter flow rates ranged from +0.09 percent to —0.28 percent. This close comparison held true on tests run by a number of other companies also.

PHILLIPS: We have consistently checked within less than 1 percent difference.

Q. *Who makes the measurements during the test?*

WHITE: The work is under the direction of an engineer in the Pipe Line department, but the rest of the men are field personnel in the districts. Our regulator men are responsible for handling the ammonia and a meter engineer is present to determine the specific gravity. The pipe line engineer works with the operating departments in setting up the test and during the test to make sure that line stability is maintained. Cooperation between the departments is essential. We request that the compressor station operate with dead weights while the line is being stabilized and during the actual test.

I might mention some of the most common errors. Watch these especially: Pressure measurements; make

ure dead weight corrections are nade. An error of 0.5-1.0 pound per square inch might not mean much between stations, but in testing a ten-mile section it is important. Incorrect time being communicated ahead—double check watch readings. Make sure corrections are made for changes in elevation and that the correct length of line is used in making calculations. Watch carefully when adding up the weights on the deadweight table—forgetting to consider the weight of the table is a common error. All deadweights should be calibrated against a standard before the test.

HUMBLE: For efficiencies taken by the operating department, we usually use men from our Measurement department who are most familiar with the equipment and procedures used. We set up the test about two weeks ahead, normally Wednesday or Thursday for most stable line conditions. The field men are notified of the time and location of the line sections to be tested.

Our dispatcher is always consulted since he usually knows of scheduled shutdowns or other conditions that would interfere with the test. He checks out the stability of flow in the line for a few days before the test and works for a stabilized condition for at least six hours before readings. If, on the day of the test, flow is sufficiently stable at 8 a.m., the field crews move out and get set up for the tests.

Readings are taken at 10:30, 11 and 11:30 o'clock in the morning. Data is collected from the field personnel by one engineer in charge of the test and computations are made in the general office. Standard forms used for recording data serve as a check list and speed calculations.

We calibrate deadweights against one weight used as standard or with a deadweight tester. Pressures at compressor stations are measured by deadweights on the pig trap barrel. In some tests the few pounds difference between the pig trap and suction and discharge will effect efficiency calculations.

PHILLIPS: Flow is leveled out by the dispatching department 12 to 24 hours before the test crews arrive in the field. Crews are supervised by engineers from the main office and supplemented by district personnel.

Q. *What degree of line stability is attempted?*

PHILLIPS: In our tests, we try to limit pressure variation to not more than 1 pound per square inch per hour. It is not always possible to hold flow that steady. However, this standard has worked out reasonably well so far. If pressure changes at the two test locations are in the same direction, variations of as much as 2 or 3 pounds in an hour have been permissible.

WHITE: The most important point, we feel, in any efficiency test is that of stabilizing flow. All calculations are based on steady flow and it is essential for reliable results.

BUKACEK: The line should be as stable as possible. The best single criterion of stability, apart from the ideal of constant measured inputs and outputs, is the stability of pressure drop across the line section under test.

Q. *Is there any effect of travel distance on detection of the ammonia?*

BUKACEK: As noted before, accurate flow rates can be determined at distances of four to twenty miles. However, for distances less than four to five miles, precision in timing and the uncertainty in pipeline mileage data limit the accuracy. At distances greater than twenty miles, it may be difficult to obtain a sufficiently sharp indication of tracer arrival.

Q. *Sometimes we have had poor results with ammonia detection—what is the minimum amount of ammonia that should be injected?*

WHITE: It depends on gas pressure, moisture content, and also its velocity. On our high-pressure lines we can get good results with only 0.5 pounds of ammonia; but on low pressure lines we normally use from 1 to 3 pounds.

Q. *What about moisture in the gas?*

WHITE: If there is much water in the gas you might not detect the ammonia at all. Certainly the results would be questionable.

Comment from audience: On tests of new loops which had been hydrostatistically tested we ran up to four efficiency tests using as much as 15 to 20 pounds of ammonia without detecting a trace. After a period of a few weeks, loops dried out and the tests were completed successfully.

ORLOFSKY: We had similar experiences where gas had a high distillate content in our gathering system.

Q. *Since ammonia is injected near the center of a test section, doesn't that make temperature less critical?*

WHITE: Yes, that's one of the reasons for injecting about midway between two compressor stations. Gas temperature is nearer to ground temperature.

Q. *What temperature is used in the flow formula, the average temperature or the mean?*

HUMBLE: Simultaneous readings of gas temperatures are taken on each side of our compressor stations and also a reading of ground temperature. Using this information, combined with curves and heat transfer coefficients developed by our engineering department, we calculate a mean flowing temperature for the line sections.

The Joule-Thompson effect in a section may also be approximated and applied. We feel that these calculated mean temperatures are accurate enough for flow tests, remembering that it takes a 10-degree change in temperature to effect a 1 percent change in line efficiency.

BUKACEK: In most cases where the temperature difference between the ends of the section is less than 20° F., it may be reasonable to take an average of the two values. The arithmetic average in this case should not differ from the mean by more than 0.5 percent. Where there is sufficiently high temperature difference, it is best to actually measure several temperatures along the line.

Q. *How are temperatures measured for the efficiency tests?*

PHILLIPS: We use a sounding rod and insert a dial thermometer with a 36-inch rod down on top of the pipe. Care is taken to get the thermometer rod in contact with the pipe. We feel that our readings are within one to two degrees of the flowing gas temperature.

BUKACEK: Preferably, temperature measurements are made by inserting a thermometer directly into the gas stream through a packing gland on a valve. Pipe wall temperatures measured in a well on the side of the pipe, or by placing a sensing element on the pipe wall and insulating it with a layer of asbestos and dirt have proven quite satisfactory. In using a bar hole to obtain wall temperatures, it is necessary to assure sensing element contact with the pipe to obtain good results.

WHITE: We have thermometer

wells on the line at most of the gate settings and temperatures are taken at enough points to plot a curve and determine the mean temperature.

Q. *In timing the flow of the ammonia slug, do you assume the elapsed time gives an average velocity for the pipe cross-section?*

WHITE: Yes. After many tests we've found that the time between injection and detection of the first trace of ammonia gives velocities that compare closely with those measured by orifice meters.

BUKACEK: Flow of the ammonia slug can sometimes be confusing. In large diameter gas pipe lines flow is highly turbulent. Because of this, some of the ammonia is tossed out near the wall of the pipe where velocity is lower. Theoretically, we don't know how to correct for this because there is a fraction of the gas moving somewhat slower than the main body. Actually we calculate flow as if the slug were moving smoothly through the pipe, and we have been able to get good results.

Q. *Are corrections for elevation change always made?*

WHITE: Not necessarily. If efficiencies were to be used by a dispatcher, elevation corrections would not be made. He is interested in how much gas he can move through the line under actual conditions and not what would be moved if the line didn't go over some hill. Where efficiency data will be used in dispatching, pressure drop in station piping should be considered if pressures for determining efficiency are not read at the same place as they are during operation.

HUMBLE: Normally, we in the Operating department do not make the elevation change correction in our efficiency tests. We do, however, have in our records elevations at test locations for others in the company who might use the data with this correction. We are primarily interested in the trend of the line performance.

Q. *How often are efficiency tests made?*

WHITE: We usually try to determine efficiencies annually. We compare results with earlier tests. If a significant efficiency decrease is noticed, we make a check run over that particular section. Trends in results are the things to watch.

Q. *What kind of accuracy can you expect in efficiency tests?*

WHITE: In earlier calculations with the Panhandle *A* equation we ran into difficulty in getting consistent results with varying rates of flow. Line efficiency should not vary with rate. This led us to revise the equation. With the new equation, efficiency does not vary appreciably with different flow rates. This equation may not be the exact answer yet, but it appears to be a step in the right direction.

We now believe that it is possible to obtain efficiencies within plus or minus 0.5 percent. This might be debatable but we are reasonably sure of a tolerance of 1 percent.

Q. *What efficiencies are considered the minimum tolerated before a pigging program is begun?*

HUMBLE: By periodic efficiency checks, we determine the trend. A downward trend indicates it is time to run scrapers. We are set up for onstream cleaning of our main lines and a cleaning program may be launched to bring the efficiency back to its normal high anytime it is necessary without curtailing the throughput of the line.

The efficiencies on the 20-, 24- and 26-inch lines of our old system average about 92 percent. The efficiencies on the 30-inch line and on other newly constructed main lines average about 97 percent.

WHITE: I don't believe that you can give a number for the answer to this question. In determining our cleaning program, we watch the trend of efficiencies from one test to another more than the actual value of the efficiency.

If one test shows a low efficiency we make another test before starting to pig the line. However, if several tests indicate that efficiencies are decreasing progressively a pigging program is started.

PHILLIPS: We are now doing considerable pigging on our South Louisiana system, because some sections of the line were down to about 75 percent.

We are getting out a large amount of foreign material and efficiencies were boosted to about 85 percent in some spreads. With a continuing pigging program, these are now up to about 88 or 89 percent and we are still working on some sections of the line.

Q. *Has the FPC recognized the new Panhandle equation?*

WHITE: Perhaps not formally, but it is used in our calculations presented before the FPC.

Q. *Do any of the panel members' companies use average monthly sales figures, average monthly temperature, and average monthly pressures for making flow tests?*

HUMBLE: Not monthly average—on some tests of sections on our 20- and 24-inch system, we use daily dispatching records and measurement records for efficiency computations. We select a day when pressure indicates the line is as stable as possible. Unfortunately we haven't made special field efficiency tests on these particular sections so we can't compare the results. This method has been used on these same sections for several years and we believe it does give us the trend needed by operations.

PHILLIPS: We have made spot checks where we have recording pressure gages at check meter stations on our South Louisiana system. I don't feel that the accuracy of pressure readings from recording pressure gages is sufficiently reliable for calculating line efficiency tests.

BUKACEK: We tried this method using average daily pressures, intake volumes and temperatures from the dispatching record of one company. The efficiencies calculated varied widely. It may be, however, that in a system less subject to load variations better results would be obtained.

Q. *Have radioactive isotopes been used for determining flow velocities?*

BUKACEK: They were used in England a few years ago in a refinery gas piping system. Although they apparently haven't been attempted in the U. S., we are thinking seriously of their use in order to better define the characteristics of tracer techniques.

There are several technical problems. First, of course, is the potential danger to personnel working with the material. A six-week training period with the Atomic Energy Commission is necessary for licensing the men who will handle the isotopes.

Selection of the proper isotope is also a problem. Methane tagged with carbon 14 is impractical because of its very long half life. Argon 41, with a half life of 1.8 hours is probably the most practical isotope, but may be difficult to transport from source to test point in proper quantities.

—**The End**

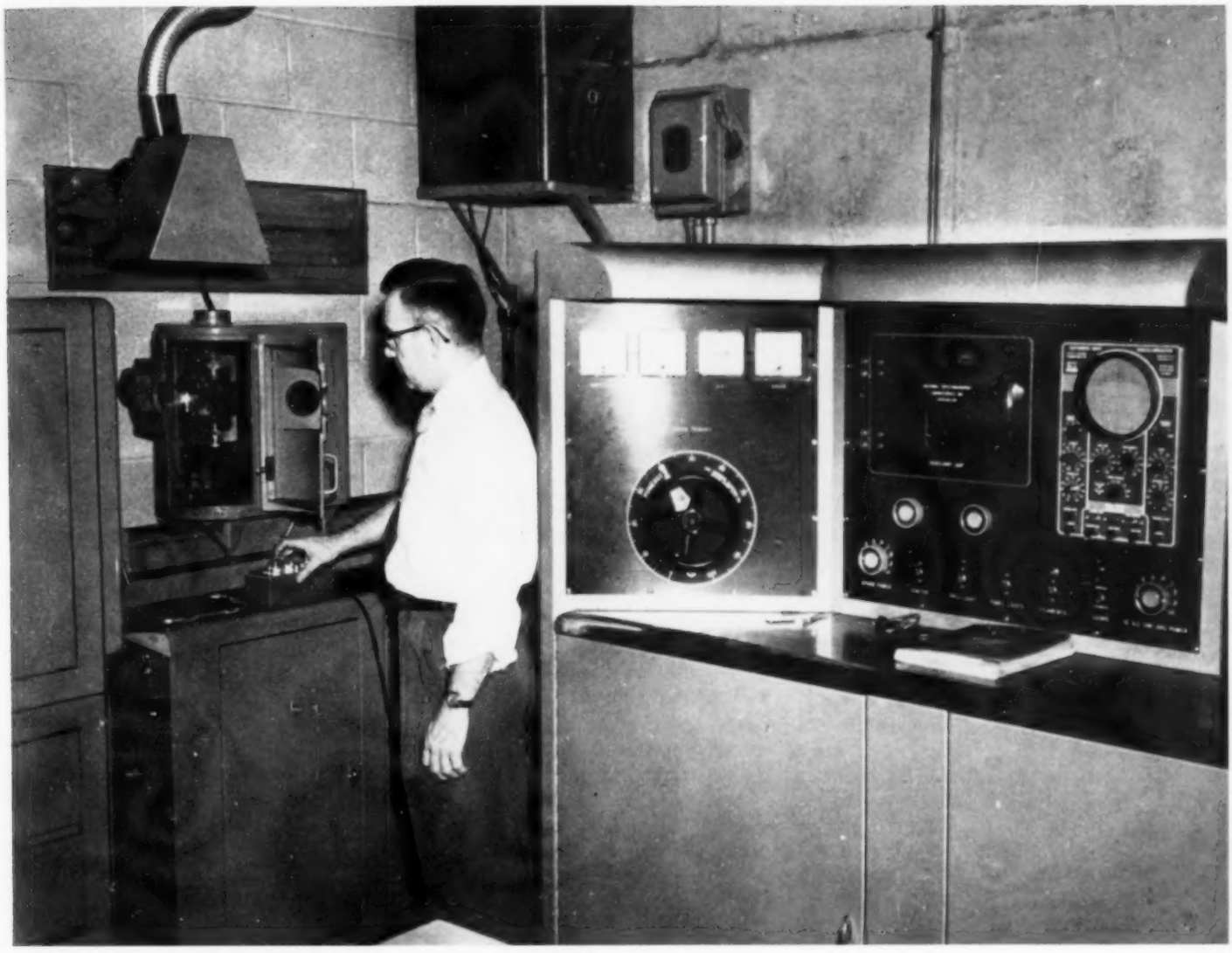

FIGURE 1—Emission spectrograph testing service lubricating oils. Shown here is the power source, arc, and condensing lens.

Lube Oil Tests Reveal Engine Ailments

Analysis of service lubricating oil with a spectrograph tells the condition of major engine components. Ring and air filter troubles are foreseen in 70 percent of tests. Nearly half of the bearing failures that occurred during tests were predicted—and experience is improving accuracy.

By J. L. WILSON
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Is IT MORE economical to repair engines on a regular schedule or run them until a breakdown occurs and then overhaul? This is a question often discussed in the gas transmission industry. Almost everyone will agree that the best answer would be to repair after considerable wear takes place but before breakdown occurs. But predicting this time is the problem. AGA research using spectrographic analysis of engine lubricating oils is now making real progress toward an answer.

Samples of lubricating oil are being

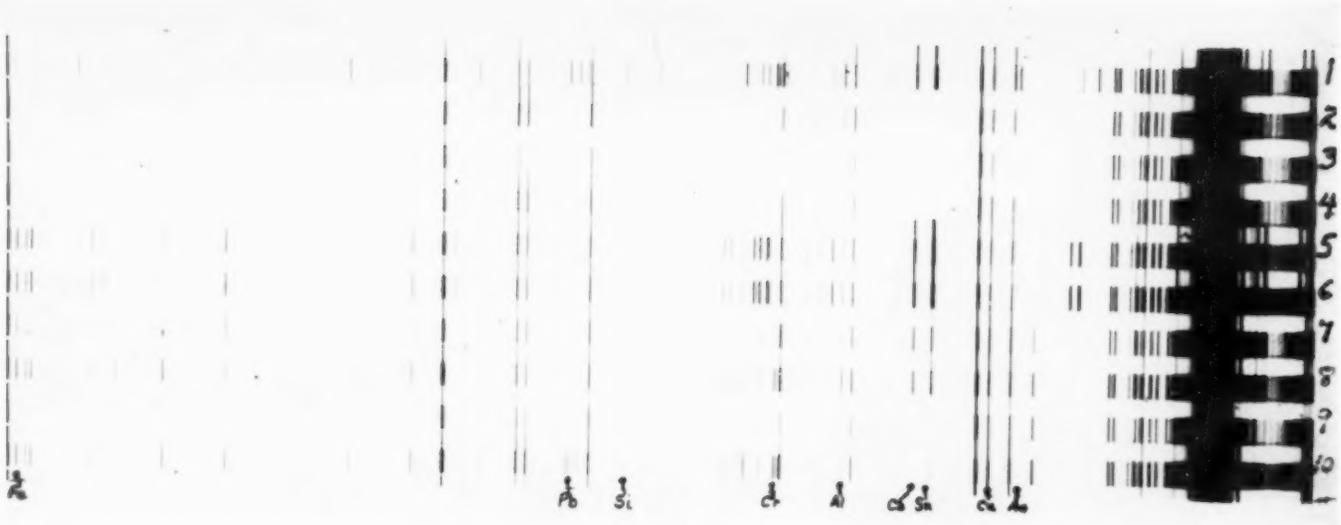

FIGURE 2—A typical spectrographic plate showing spectra lines used in lube oil analysis. Degree of darkness of lines tells how much of a particular metal is present in the sample.

taken from 75 engines of various makes and types by 11 major transmission companies. Each sample is analyzed by an emission spectrograph and results are correlated with measured wear rates, operating conditions, and parts failures where they have occurred. Results promise reduced maintenance costs, greater engine availability, and more efficient use of maintenance labor.

This problem had been attacked earlier using various physical and mechanical means. But until now no sure solution had been found. Tests of lubricating oil provide a good line of study stince the oil contacts all moving parts subject to wear and actually removes the wear products. Analysis and identification of these products and contaminants furnish information on general wear and more important the wear of specific parts.

Wear products and contaminants are only slightly soluble in the oil. Thiey are generally present in such minute quantities that the standard methods of chemical analysis are of little value. The large volume of an oil sample needed to obtain enough residual contaminant for analysis rules out the use of gravimetric or volumetric methods of analysis.

Use of radioactive parts to study wear is relatively new and no standards exist for the comparison of results. Some experimentation has been done with small engines, but the large size of compressor engine parts, the limited radioactive sources for activating the parts, and special handling techniques required for this method make it impractical at present.

Spectrographic Analysis Is Practical. For present tests, the emission spectrograph is the most feasible of the instrumental methods available. It requires only a small sample; it is sensitive in detecting trace amounts of metals and metal compounds in a wide variety of materials; analytical techniques have been worked out and proved; standards of comparison are known. Pioneer work by the railroad industry with locomotive engines furnishes a background of experience for interpreting results.

Essentially, the emission spectograph is an optical instrument. A sample of material to be analyzed is vaporized by an electric arc between two electrodes. This produces a radiation of definite wave lengths in the ultra-violet range. The radiation is focused through a condensing lens on a slit ranging from 10 to 200 microns wide. It is then dispersed into its individual wave lengths using a refracting prism or a diffraction grating, and focused on a photographic plate where the spectrum appears as a series of lines (Figure 2).

Each line on the plate is an image of the slit and represents a wave length present in the original source. Each element has several characteristic wave lengths by which it may be identified. With proper choice and control of the existing energy, slit width and exposure time the density (or blackening) of the images on the photographic plate is proportional to the concentration of the elements in the sample.[1]

Test Engines. The 75 engines now under test are representative of the various makes and types of compressor engines generally used for gas transmission. Several engines were included because they may be forerunners of the future trend in compressor engines. These special engines include a vapor-phase cooled engine, several of the new types of turbocharged engines and converted turbocharged units.

This AGA test program began in September 1955 and will continue for one year. A sample of lubricating oil from each engine is taken monthly and sent to the Institute of Gas Technology where it is analyzed spectrographically. Information about the operating histories of each engine, general conditions of repair, available wear records, materials of construction and oil filtration equipment was sent to the Institute at the start of the tests. Pertinent operating data, report of unusual weather conditions, oil filter changes, and repair work performed during the month are sent in for each engine on test each month.

How Wear Is Determined. Oil samples are analyzed for eight materials: silicon, iron, chromium, aluminum, copper, lead, tin, and boron. Two physical tests, pentane insolubles

ASTM D-893), and neutralization number (ASTM D-974), are also run on each sample. These components, separately and in various combinations, are used as indicators for wear of the various parts of the engine. The physical tests are run with the feeling that some correlation exists between the spectograph results and physical results.

Silicon is generally considered to be the best indicator of dirt and particularly air-borne dirt. The principal source of dirt in large engines such as compressor engines is the combustion air supplied to the engine. The quantity present is usually dependent upon the degree of air filter maintenance.

Iron is an indicator for unusual wear conditions in almost any part of an engine since the major constituent of the engine is iron. Iron can indicate excessive wear of rings, pistons, cylinders, crankshaft journals, gears and other parts. Therefore a combination of elements must be used to pinpoint the source of the iron and the part that is wearing.

Chromium is an indicator for several sources of trouble. Many engines use chrome plated liners or piston rings, and chromates are commonly used to treat the cooling water. If a water leak into the crankcase develops, the water evaporates leaving behind the chromate.

Aluminum is used as an indicator to detect bearing wear on engines which have aluminum bearings.

Copper, being a constituent of most bronzes, brasses, and babbitts, is an indicator for wrist pin, bearing, and ring wear where bronze rings are used.

Lead and tin are indicators for bearing wear since they are constituents of the tin base babbitt normally used as bearing metal for compressor engines.

Combinations of Wear Elements. Combinations of elements must frequently be looked for to determine or predict conditions within an engine. A knowledge of the various materials used in an engine is also necessary for a correct interpretation of wear conditions. For example, a high iron content alone could indicate excessive wear in the power cylinder area provided the cylinders, pistons, and rings were iron and not plated with some other metal. If chrome rings or chrome plated cylinders were used, then a high chrome content would be expected in a combination with the high iron content. Tinnized pistons, when worn excessively, would result in a high tin content in conjunction with a high iron content.

If the high iron content is due to excessive ring wear, there is usually blow-by into the crankcase of combustion gases, and the best indicator for such blow-by into the lubricating oil is the pentane insoluble test which is a measure of the amount of such blow-by. The pentane insolube test is not usually taken into account in interpreting results unless the value is high. High iron content in combination with high tin and lead would possibly indicate excessive crankshaft wear due to bearing trouble.

Several tabulations of analyses will best demonstrate how the various metals alone and in combination have been used to correlate wear conditions and failures in compressor engines with spectrographic analysis results. This and the other data are taken from engines on test in the AGA research program and from engines on the Texas Gas system.

Case I—Normal Engine Operation. This first group of analyses (Table 1) is from an engine in which operation is normal. This engine is lubricated with non-detergent naphthene base oil and is equipped with a by-pass, fullers earth type filter. During the period shown it operated at an average load of 90 percent.

Analyses in Table 1 cover a period of a year. This engine was overhauled just prior to the first sampling date in April of 1954 and was overhauled again in April of 1955. At that time new type power pistons and aluminum main bearings were installed. These changes were made not because of excessive wear or deterioration, but because of a decision to standardize on these new parts. Measurements did not show appreciable wear in any part of the engine, and it can safely be assumed that this engine could have run for a considerable length of time longer without need of repair or overhaul.

Some of the variations between the individual analyses are due to the addition of quantities of fresh oil to the crankcase. Approximately 200 hours of operation are required after an oil change until the analyses begin

About the Author

J. L. WILSON, chemical analyst for Texas Gas Transmission Corporation, graduated from Louisiana Polytechnic Institute in 1949. Following graduation he went into the Gas Measurement department of Lone Star Gas Company for two years. Since joining Texas Gas in 1951, Wilson has been responsible for water treatment and lubrication control in the Compressor department.

TABLE 1—Spectrographic Analyses With Normal Engine Operation

	DATE OF SAMPLE											
	5/1/54	6/15/54	7/15/54	9/1/54	10/1/54	11/1/54	12/1/54	1/1/55	2/1/55	3/1/55	4/1/55	5/1/55
	CONTENT—PARTS PER MILLION (P-1 indicats less than 1 ppm)											
Pentane Insoluble	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silicon	2	2	1	3	1	1	1	1	1	1	3	3
Iron	2	P-1	P-1	1	1	2	2	2	1	4	7	5
Tin	1	P-1	P-1	1	2	2	2	1	1	1	1	P-1
Aluminum	P-1	P-1	1	1	1	1	3	1	1	1	1	1
Copper	4	P-1	P-1	1	P-1	1	1	1	P-1	1	1	1
Lead	5	P-1	1	1	P-1	1	1	1	1	2	2	4

showing stable values again. Filter changes, particularly if earth type filters are used, have a tendency to distort the analyses. The filters on this engine were changed on June 7, 1954, and again on January 25, 1955, and the samples taken just following the filter changes in June 1954 and January 1955 show virtually a minimum value for all elements.

Table 1 then emphasizes what is probably the greatest potential of spectrographic analysis of used lubricating oils. By proper interpretation of analyses, using a background of previous analyses, the operating period between overhauls can be economically extended.

Case II—Ring and Cylinder Wear Suspected. Engine data of Table 2 show an abnormal increase in iron content. Ring and cylinder wear was suspected. But as this engine was scheduled for an early overhaul it was kept in operation until that time.

It was in service compressing low-pressure gas to transmission line pressures in two stages. It operates about 98 percent of the time, and during the fall and winter months at an overload of about 5 percent. When it was overhauled in March 1956, micrometer readings indicated that approximately 0.003 to 0.005 wear had taken place in the cylinders. All rings on several pistons were badly worn and had to be replaced.

The top half of one main bearing was also damaged and had to be replaced. This is indicated by the abrupt change in tin, lead, and copper on the January analysis. At that time silicon also increased.

This entire analysis, when reviewed in light of the subsequent overhaul, bears out the engine wear theory voiced by H. R. Sennstrom of American Locomotive Company, which is roughly: "It is surmised that dirt first damages the upper rings. As these rings continue to operate in a damaged condition, particles worn from their surfaces work downward through the assembly and cause damage to the lower rings and pistons. The wear particles then are carried to the bearings and cause scratching and deterioration of the bearing surfaces, as indicated by the increase of the bearing metal content in the lube oil."[2]

Case III—Crankshaft Failures Occurred Soon After Lube Oil Analysis Began. Analyses in Table 3 are from an engine in which a crankshaft failure was experienced. Unfortunately this failure happened just after the second sample was taken and it is quite possible that this failure could have been prevented if sufficient previous spectrographic information about conditions in this engine had been available.

The November sample was taken just prior to the crankshaft failure. Tin, lead, and iron content increased greatly. If analyses for August and September had been available, the bearing failures responsible for the crankshaft failure might have been predicted.

Case IV—Progressive Wear Up to Overhaul. Table 4 shows that a single spectrographic analysis by itself is useless in attempting to predict failures, deterioration or excessive wear in engines. Table 4 is a series of analyses from an engine in which gradual wear was experienced in the rings and liners. When these reached a certain point of deterioration, bearing trouble began and progressively got worse until the engine was overhauled.

The analyses show minimum values for everything for several months. A dust storm occurred in October and the air filters were cleaned on the basis of this analysis. At this time the iron content increased greatly. In December the iron had increased further and the lead and tin started to climb. In February and March the

TABLE 2—Spectrographic Analyses Where Ring and Cylinder Wear Occurred—Bearing Wear Followed

	DATE OF SAMPLE						
	10/25/55	11/25/55	12/26/55	1/25/56	2/24/56	3/26/56	4/25/56
	CONTENT—PARTS PER MILLION						
Pentane Insoluble	0.02	0.01	0.00	0.05	0.01	0.00	0.00
Neutral Number	0.1	0.3	0.2	0.3	0.3	0.9	1.1
Silicon	1	1	1	7	7	4	3
Iron	2	6	15	59	64	36	20
Chromium	1	P-1	P-1	P-1	P-1	P-1	P-1
Aluminum	P-1	P-1	1	1	1	1	1
Copper	1	1	1	3	3	3	2
Lead	1	1	1	2	2	2	3
Tin	1	1	1	3	4	4	4

TABLE 3—Spectrographic Analyses from Engine Where Crankshaft Failure Occurred.

	DATE OF SAMPLE						
	10/13/55	11/10/55	12/10/55	1/10/56	2/10/56	3/10/56	4/10/56
	CONTENT—PARTS PER MILLION						
Pentane Insoluble	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Neutral Number	1.1	0.7	0.7	1.0	1.3	1.8	1.4
Silicon	4	4	4	3	5	4	3
Iron	11	19	14	20	47	42	25
Chromium	P-1	P-1	P-1	P-1	P-1	P-1	P-1
Aluminum	2	2	2	2	2	2	2
Copper	P-1	1	1	2	1	1	1
Lead	16	26	13	6	14	10	10
Tin	3	6	4	4	3	2	2

TABLE 4—Progressive Wear Indicated by Spectrographic Analysis

	DATE OF SAMPLE											
	6/17	7/15	8/15	9/15	10/15	11/15	12/15	1/15	2/15	3/15	4/15	5/16
	CONTENT—PARTS PER MILLION											
Pentane Insoluble	0.00	0.01	0.01	0.01	0.02	0.01	0.03	0.03	0.02	0.01	0.01	0.00
Silicon	1	1	2	1	4	1	1	1	1	1	2	1
Iron	1	2	3	3	11	18	27	20	21	17	10	1
Tin	1	1	1	1	1	1	2	3	3	2	1	P-1
Aluminum	P-1	1	P-1	P-1	1	P-1	1	1	2	2	1	1
Copper	P-1	P-1	1	P-1	P-1	P-1	1	P-1	P-1	1	P-1	P-1
Lead	P-1	1	P-1	1	1	1	2	4	7	5	2	P-1

engine was overhauled. New liners, new rings, and seven new bearings were installed.

At that time experience in interpreting these analyses was very limited so only a guess was ventured in early February that there might be some bearing trouble. A review of the analyses after the overhaul will help predict the condition of an engine in the future.

Case V—Single Analysis Can Be Misleading. In Table 5 is a good example of how misleading a single analysis can be when an interpretation is attempted using it as a basis. A considerable amount of bearing trouble had been experienced at this station so spectrographic analysis of lube oil samples was started at an early date.

When the first analysis (sample of June 15) was received, the conclusion was drawn that most of the bearings on this engine were gone. After a telephone conference in which the station manager said that the engine was running perfectly, it was agreed to wait for the next analysis report. The company running the analyses telephoned immediately after analyzing the June 30 sample to say that they felt bearing failure was imminent in this engine.

The engine was shut down immediately and every bearing inspected and measured in every possible way. All of the bearings were good as new; there was absolutely nothing wrong.

In discussing the situation it was revealed that a plastic lead compound was used to seal the gaskets on the crankcase inspection plates. It was confirmed that this was the source of lead in the oil by dissolving some of the compound in a sample of new oil, filtering the sample and sending it off for analysis. The analysis of that sample showed 500 parts per million lead. So lead is not now considered to be a reliable indicator of bearing trouble on engines where a lead compound is used to seal gaskets on inspection plates.

These examples are special cases selected to illustrate specific points about the interpretation of spectrographic analyses of service lubricating oils. Many failures have been experienced in interpreting and predicting wear and we are not entirely satisfied with success in predicting bearing trouble. Only 3 cases out of 8 have been predicted correctly, and bearings have flaked out in several engines where it was not indicated. Our success at predicting ring wear and air filter trouble has been much better. It is approaching 70 percent.

Case VI—Different Types of Oil Can Lead to Wrong Diagnosis of Engine Trouble. Engines represented in these examples were lubricated with a non-detergent mineral oil because most experience in interpretation had been with analysis of this type oil. Definite conclusions have been impossible from analyses where a detergent type oil is used as indicated in Table 6.

This engine had been recently overhauled and only a negligible amount of wear found in any part of the engine. From the data and experience with non-detergent oils it would be suspected that: (1) the bearings were near failure as indicated by the high lead, tin and copper values; and (2) the rings, liners, piston and crankshaft were badly worn because of the high iron content. The greatest difficulty in interpreting analyses where detergent oils are used seems to arise from the fact that each oil company uses a different group of additives in varying amounts in compounding their detergent oils. More experience with these oils should help to overcome this barrier.

Use the Spectrograph as You Would Any Other Maintenance Tool. It has been found that different makes of engines tend to carry different normal levels of these metal contaminants in the lubricating oil. In addition, it has been noticed that the same make engine when lubricated with different oils seem to have differing normal contaminant levels. So when these characteristics are combined with the many different combinations of operating difficulties, it becomes almost impossible to set down rules for exact interpretation of spectrographic analyses. However, from experience and knowledge of the engine and conditions we have been able to interpret correctly the results of this analysis in a great many cases.

The spectrograph is a maintenance tool of great potential, but at the same time it is not a cure-all to take the place of present maintenance procedures.

TABLE 5—Bearing Trouble Suspected Did Not Occur. Lead Based Gasket Sealing Compound Caused Misleading Results

	DATE OF SAMPLE									
	6 15	6 30	7 15	7 30	8 15	8 30	9 15	9 30	10 15	11 15
	CONTENT—PARTS PER MILLION									
Pentane Insoluble	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Silicon	1	1	1	4	1	1	3	6	1	2
Iron	5	4	5	5	3	2	4	4	4	5
Tin	1	1	2	1	2	2	3	2	2	2
Aluminum	4	3	2	2	2	1	2	1	1	1
Copper	7	7	3	2	2	1	2	3	2	3
Lead	43	75	71	42	40	34	45	50	33	29

TABLE 6—Analyses of Detergent Oil Can Be Confusing Based on Past Experience With Mineral Oils

	DATE OF SAMPLE					
	11 4 55	12 5 55	1 4 56	2 3 56	3 5 56	4 4 56
	CONTENT—PARTS PER MILLION					
Pentane Insolubles	0.09	0.01	0.05	0.00	0.01	0.00
Neutral Number	1.1	2.9	3.6	3.7	3.7	3.3
Silicon	16	8	4	9	9	8
Iron	89	G-70	70	G-75	G-75	G-75
Chromium	P-1	P-1	P-1	P-1	P-1	P-1
Aluminum	1	2	2	1	1	2
Copper	23	G-50	38	18	20	3
Lead	80	56	44	46	43	73
Tin	4	5	5	6	5	6

REFERENCES

1 "Instrumental Analysis," Harley and Wiberly, John Wiley and Sons, Inc., New York, (1954), p. 124.

2 "Symposium on Spectrographic Analysis of Diesel Engine Lubricating Oil," (May 1952), Sponsored by American Locomotive Company.

ACKNOWLEDGMENT

Presented at the Eleventh Annual Short Course in Gas Technology, Texas College of Arts and Industries, Kingsville, Texas, May 30-June 1, 1956.

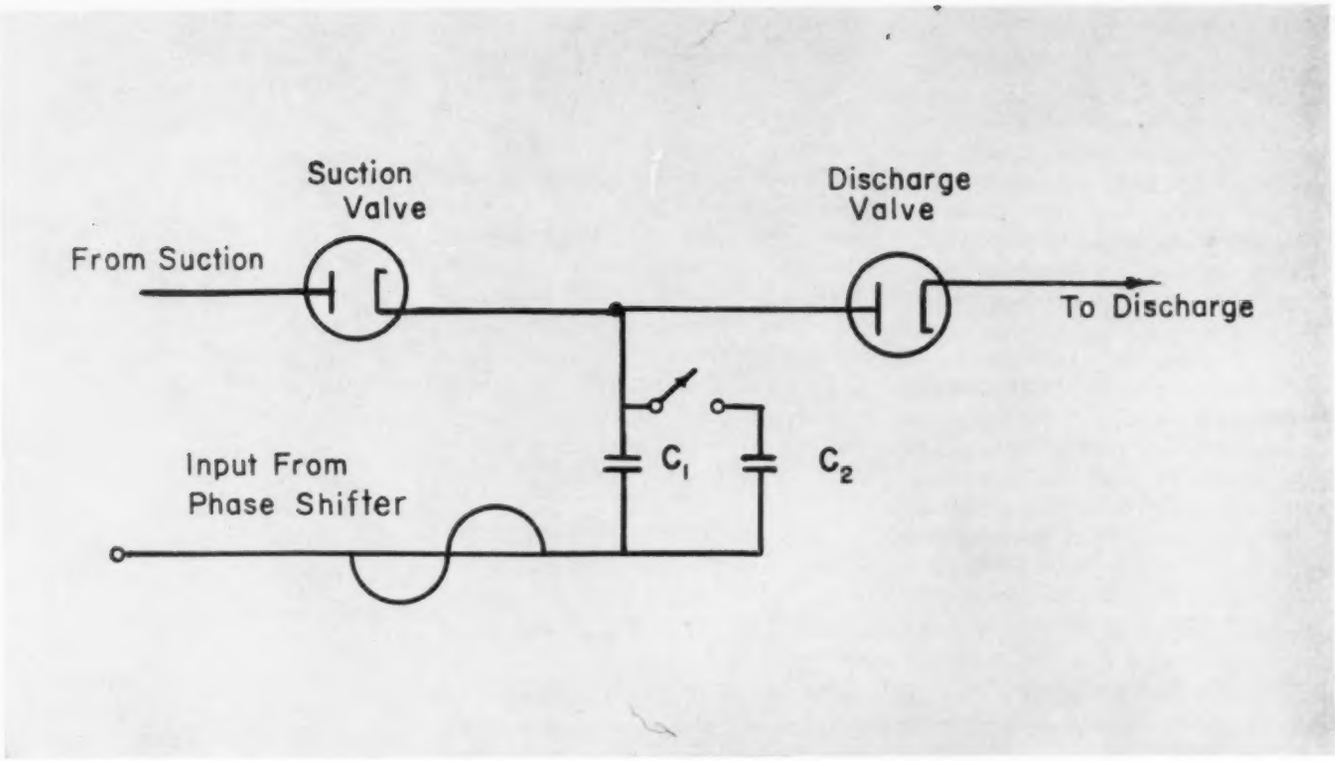

FIGURE 1—Electrical schematic of constant delay line.

SGA and Southwest Research Team Up To . . .

Take the Pulse of Compressor Piping

Electro-acoustical analog speeds solution of piping design problems in new stations and simplifies modifications to existing ones. Thirty problems have been solved successfully.

By GLENN DAMEWOOD
Southwest Research Institute
San Antonio, Texas

THE ELECTRO-ACOUSTICAL analog is rapidly proving itself a fast and accurate method of evaluating compressor station piping systems. Thirty design problems have been worked out in the Southern Gas Association research program for gas transmission companies. Its general acceptance is approaching that of an industry standard.

Use of the analog has not only led to the development of new methods for controlling pulsation and acoustical vibration but has also influenced new field measuring techniques and field data interpretation.

The analog is not a computer in the sense that it can solve complicated equations. Instead, it is an electrical model of a compressor and its associated suction and discharge piping. Every electrical element in the analog corresponds directly to a mechanical element in the compressor system so that electrical measurements on the analog are equivalent to field measurements at a compressor station.

Basic Analogy: Pressure and mass flow correspond to electric potential and current. At least three electrical analogies have been proposed to represent an acoustical system. Although all of these may be used, the pulsation problem is best represented by the classical analogy: Pressure represented by electrical potential and mass flow by current. The pulsation is represented by AC potential and current; the static pressure and flow are represented by DC potential and current.

Cylinder geometry and rotational speed of prime mover represented. Because the timing sequence of the compressor cylinders is one of the variables of any pulsation problem, it is necessary to represent both the geometry and rotational speed

of the compressor crankshaft. This is done with a variable frequency oscillator and phase shifters. The oscillator generates a sine wave for driving the compressor cylinders at a frequency which is a multiple of the rotational speed of the crankshaft in revolutions per minute. Phase shift networks represent the angles between crank throws. This system makes it possible to analog a maximum of six double-acting compressor cylinders driven from a common crankshaft.

Constant delay lines represent piping. Since electric waves travel on a transmission line in much the same way as acoustic waves in a conduit, it is possible to represent any piping system with suitable transmission lines. These lines could be parallel wires, but it is more convenient to use a system of lumped constant delay lines. The electro-acoustical analog uses a finite number of such sections as its artificial delay line. A typical section is represented in Figure 1.

Each section contains a coil or inductance that represents a given length of fixed diameter pipe and a pair of condensers chosen as a function of the diameter of pipe and the velocity of sound through the fluid in the pipe.

In practice, each section of line usually represents a one-foot length of pipe and is a plug-in unit so that combinations can be set up easily and quickly. Condensers are separate units which may be combined and attached to the coil sections.

Capacitor corresponds to a single-acting compressor cylinder. A very important step in developing this analogy was the correct representation of the compressing action of a cylinder. The analogy exists between the charge carried per cycle of the electrical system and the mass of fluid pumped per piston stroke. This is diagramatically shown in Figure 2.

The action of cylinder valves is represented by diodes, which cut off electrical current just as a valve cuts off gas flow. Electrical current flows easily from the anode to the cathode of the diode, but cannot flow in the opposite direction. The piston of the pump is represented by a condenser connected to the diodes on one side and to an output of the phase shifter or crankshaft on the other. Just as the piston is driven by a crank throw, sucking gas through the suction valve when moving one way and forcing it out through the discharge valve when moving the other, so the condenser moves electricity in through the suction diode when the driving wave from the phase shifter is going down and forces it out through the discharge diode when the wave is increasing. The condenser in Figure 2 is shown as C_1 and C_2 because the valve is a function of clearance volume. It is therefore possible to represent clearance pockets as condensers which may be switched into the circuit to effect a change in loading conditions.

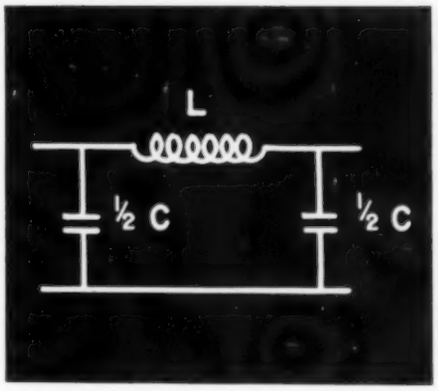

FIGURE 2—Simplified diagram of cylinder-capacitor pump.

Compressor Station Analogy Table

Electric System	Mechanical System
DC voltage	Static pressure
AC voltage	Pulsating pressure
DC current	Steady gas flow
AC current	Pulsating gas flow
Frequency of electric waves	Frequency of acoustical waves
Wave velocity	Velocity of sound in gas
Electric dimensions, reactance of electric wave filter component	Mechanical dimensions, acoustic reactance of a given pipe section containing gas at a specified temperature
Electric controls, germanium diode	Compressor controls, valve in compressor cylinder

Station design data provide basis for analog study. The analog analysis of an existing or proposed station requires that the basic data for the problem be submitted by the gas company. A standard data sheet is provided which contains the following general information:

- Compressor speed
- Operating conditions of pressures and temperatures
- Compressor sequence
- Physical constants of the gas
- Cylinder sizing data such as bore, stroke, rod diameter, fixed and variable clearance, and loading curves.

In addition, a description of the problem is required with drawings of all physical limitations to piping design or changes.

From these data the voltages and capacitor sizes are computed for the compressor analogy and the constants for the artificial delay lines are determined. It is then a routine matter to pipe the compressor according to existing piping drawings or proposed schematics and to calibrate the capacitor pump units to operate under the desired conditions of speed, pressure, temperature and pocket settings.

The analog does not predict the best piping system to use. But it does analyze the operational characteristics of any system and provide a quick method of comparing proposed designs.

What kind of problems will the analog handle? Three general classes of problems have been investigated:

1. **New design:** these problems are

About the Author

GLENN DAMEWOOD, research physicist with the Southwest Research Institute, San Antonio, Texas, is project engineer for research and development of the electro-acoustical analog. He was graduated from Texas College of Mines with a degree in physics in 1949 and did graduate work at the University of Texas. Damewood worked with U. S. Army field forces at Fort Bliss, Texas, as chief of field instrumentation and later as assistant chief of instrumentation at White Sands Proving Grounds.

Prior to joining the Research Institute in 1955, he was senior engineer with El Paso Natural Gas Company.

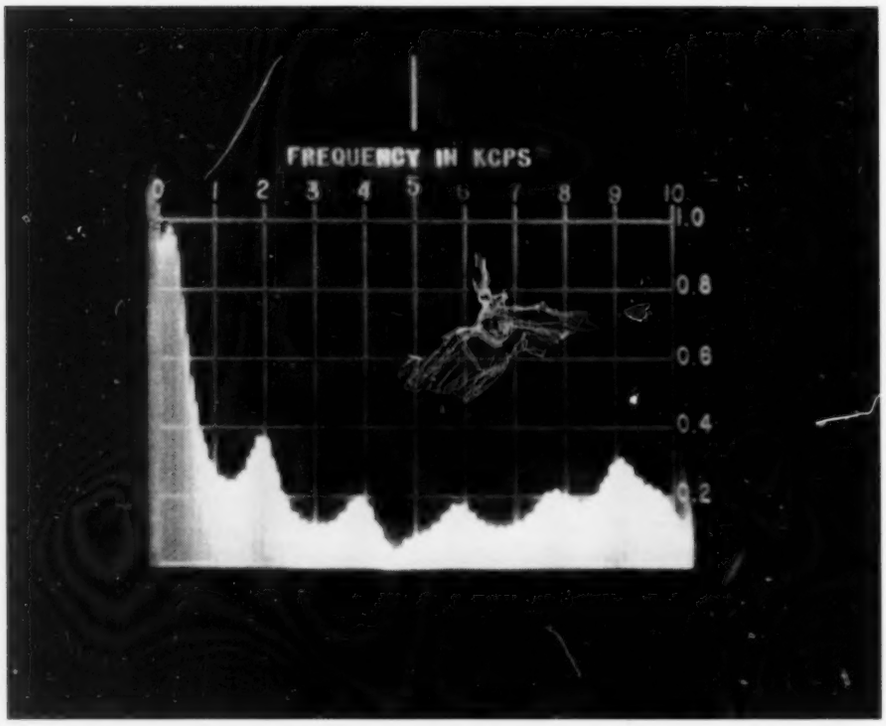

FIGURE 3—Transmission characteristics. Oscilloscope presentation of the frequency response curve for a piping system.

usually studied to design piping for good compressor performance, adequate pulsation filtering and maximum protection from acoustically excited vibration.

2. **Vibration problems:** the general problem is to modify existing piping to reduce vibration and still keep changes to a minimum.

3. **Compressor loading problems:** occasionally the loading characteristics of a unit must be changed on a system where vibration is not a serious problem. It is then only necessary to design pumping to alleviate the loading condition without introducing a new vibrational problem.

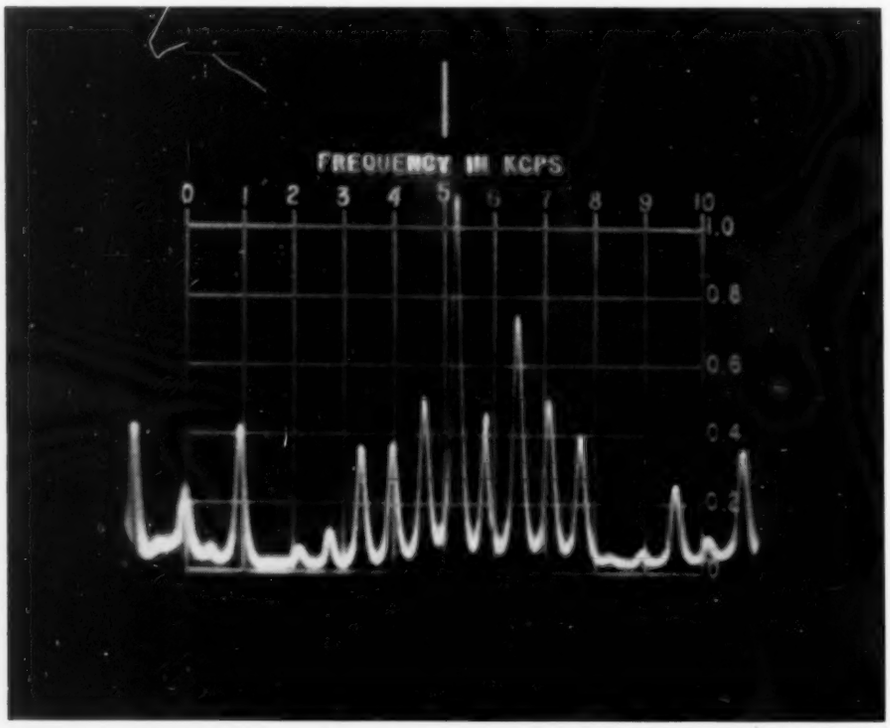

FIGURE 4—Frequency analysis. Oscilloscope presentation of amplitudes and frequencies of pulsation.

Determination of the frequency response of a system is often first step in evaluating system. The frequency response curve for a piping system or portion of that system can be determined easily and quickly with the analog. A typical transmission curve is shown in Figure 3.

These particular data can be obtained by exciting the piping analog with a sweep frequency generator and measuring the output at some point in the system. The vertical scale represents amplitude of the output signal and is plotted with respect to frequency. This curve will then be a direct measurement of the effectiveness of the filtering achieved by the piping section. Peaks indicate the transmission regions of the system and are caused by resonant conditions in the piping.

Location of resonant frequencies and the shape of resonant response curves are of prime importance in piping design. This measurement could be made in the field by driving the piping system with a loudspeaker and measuring the output of a microphone, placed in the piping, as the frequency of the speaker output is changed. There are two major objections to this method. First, the piping would have to be fabricated; and second, the control of acoustic input and output impedance is difficult under field conditions. Both of these objections are avoided with the analog.

Frequency Analysis shows standing waves produced in pipe line by compressor. The final analog test for the pulsation and vibration control effectiveness of a piping system is made by allowing the compressor analog to excite the delay line representing the piping and to observe the frequency analysis of the complex electrical wave at the proper locations in the piping system. A typical frequency analysis is shown in Figure 4. The vertical scale can be calibrated directly in pounds per square inch pressure and is plotted with respect to frequency. By choosing the points of observation in the

piping system, this technique will correctly define the standing waves created in the piping by the compressor.

It is also possible to determine the acoustic forces which can produce vibration and to measure the predicted pressure of any harmonic of engine speed anywhere in the piping system. These measurements may also be made in the field if pressure taps are provided at the correct locations. The analog is not hampered by this limitation because measurement points are provided at least in one-foot increments throughout the entire piping system.

Analog cards show volumetric efficiency, indicated horsepower and capacity of pump. The determination of cylinder loading characteristics on the analog is made from an analysis of pressure-time and pressure-volume cards taken on the capacitor pump units. Representative cards are shown in Figures 5 and 6.

Cylinder diagrams are presented directly on a cathode-ray oscilloscope and maintain direct relationship with the mechanical system for valve opening and closing times, amplitude, and the shape of the wave when both suction and discharge valves are open. These cards may be analyzed for volumetric efficiency, indicated horsepower and capacity in the same manner as a conventional MIT record.

Other field measurements possible. It is also possible to make analog observations of any field measurement of pulsation. Some of these quantities expressed in terms of the equivalent field measurement are:

- Static pressure
- Peak-to-peak or root mean square pulsation pressures
- Average mass flow
- Peak-to-peak or average mass flow variations
- "Beats" between two units.

The principles developed by SGA and Southwest Research Institute have led to many successful station designs and have solved complicated problems where earlier attempts had failed. The electro-acoustical analog is becoming a valuable station design tool.

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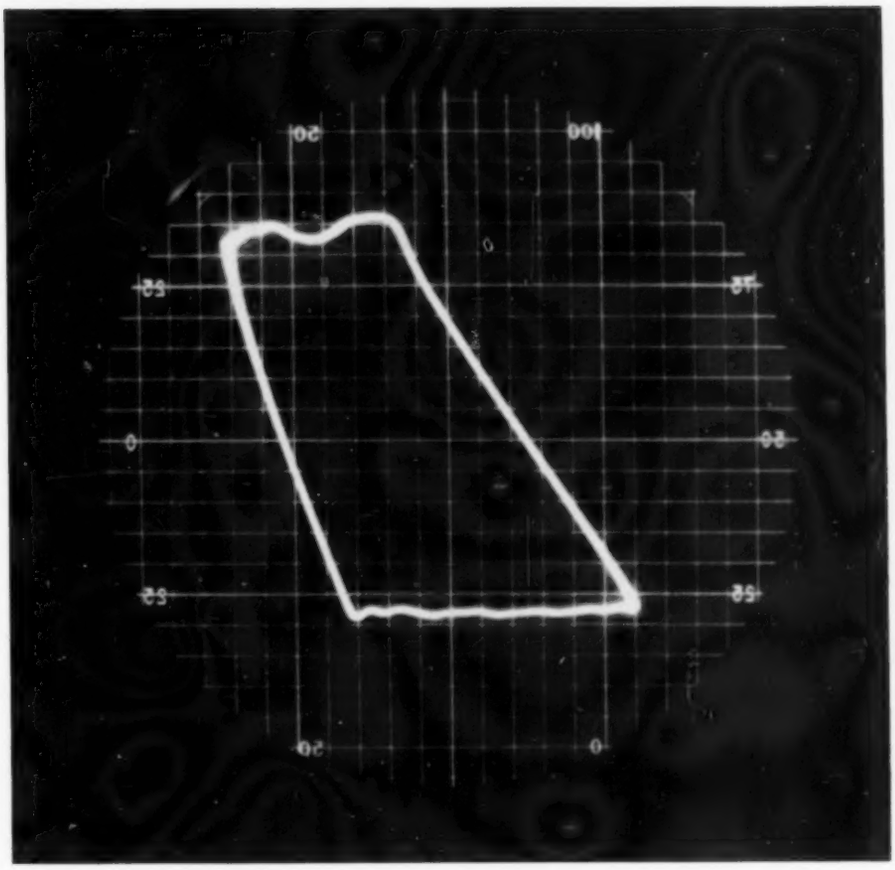

FIGURE 5—Analog PV card.

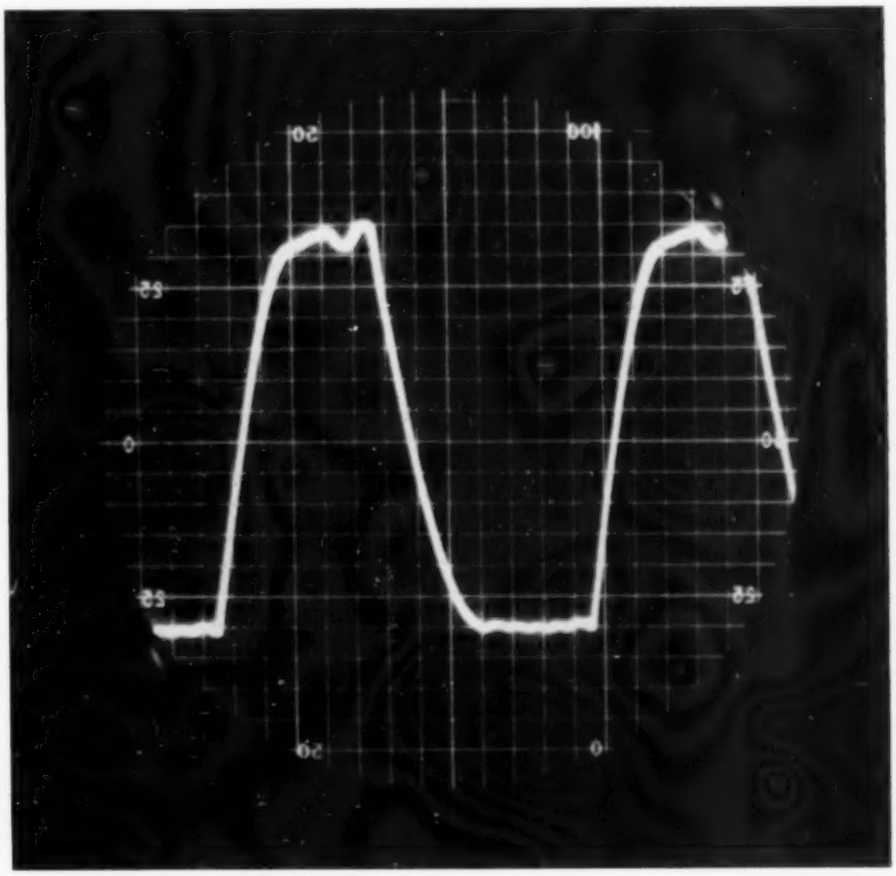

FIGURE 6—Analog PT card.

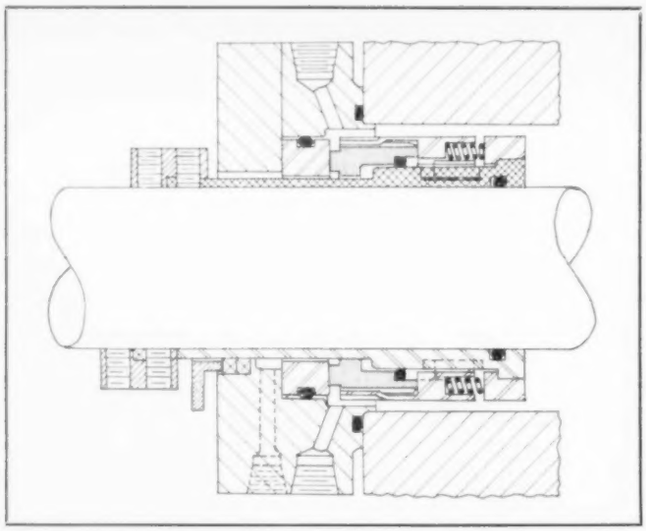

FIGURE 1—Internal seal mounted on a sleeve locked to the shaft outside the gland. This cartridge type seal facilitates maintenance.

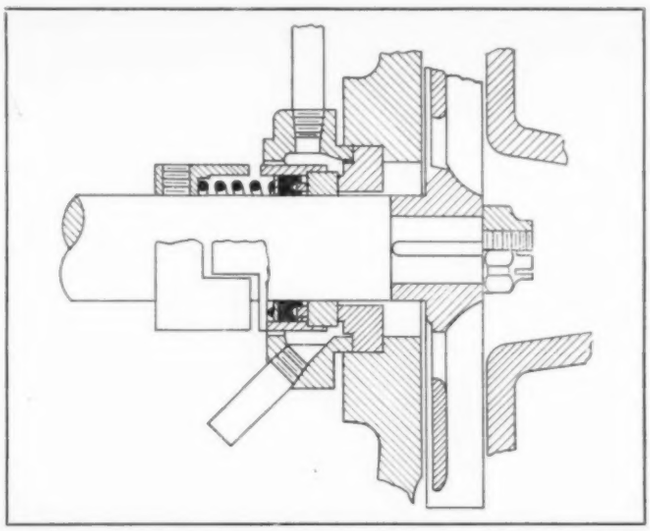

FIGURE 2—External seal assembly with rotating element outboard the stationary element.

Getting the Most From Pump Seals

These basic ideas are guides to good installation and maintenance practices. Top performance demands careful attention to both.

By TED J. SNIFFEN
Worthington Corporation, Houston

IN MODERN PIPE LINE pump stations, elimination of stuffing box leakage is a must for safe and economical operation. Losses, hazards, and downtime put a premium on reliable operation of mechanical seals. Increased use of automatic control demands top performance. Seals in use today have many improvements over early attempts to solve stuffing box leakage problems.

The first solutions were simply modifications to conventional packed boxes by addition of more packing rings, cooling jackets, harder sleeves and various lubricating devices. This trend took another direction with the application of a mechanical device to control leakage. Early seals combined conventional style packing rings with metallic elements along the basic lines of today's mechanical seals.

These devices were accepted as an improvement in existing methods, but the original single seal designs were not completely reliable.

Developments in Pipelining—A variation was the use of two seals back-to-back with clean lubricating liquid injected between them to handle the tougher jobs. This arrangement, the so-called double seal, requires the extra expense and maintenance of auxiliary seal oil equipment and introduces the risk of product contamination.

Continuing developments in seal design and materials increased confidence in single seal performance to the extent that double seals are now generally used only for extremely hazardous applications.

Pipe line pumps today generally use seals similar to the one shown in Figure 1. This is an internal seal, mounted on a sleeve locked to the shaft outside of the gland. This arrangement, commonly called a cartridge type seal, facilitates maintenance.

Mechanical seals are not the answer to all stuffing box problems, but when properly applied they can show a marked reduction in pump operating and maintenance costs. An understanding of the fundamental functions of the various seal parts is essential to successful application.

Basic Seal Elements—The single type mechanical seal consists of a rotating element fixed to the shaft or shaft sleeve, and a stationary element which is fixed to the pump casing. Adjacent surfaces of these two elements in a plane normal to the shaft have highly polished faces with a low coefficient of friction to permit extremely close contact. The other parts of the seal provide compensation (flexibility) for wear, machining tolerences and deflections, and insure sealing at static points between parts that have no relative motion with respect to each other. Two versions of the single seal in common use are the internal type (Figure 1), which is mounted within the stuffing box, and the external type (Figure 2), which

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1,325, or 37.8% replied.

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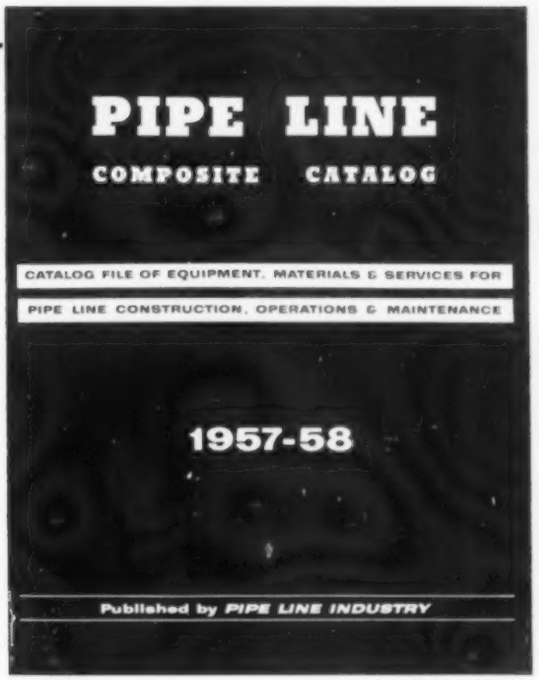
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Four thousand copies of the Pipe Line Composite Catalog will be printed and distributed among oil, products, and gas line employees, executives, purchasing department personnel, superintendents, engineers, and other key men whose names will be furnished by the companies employing them. Similar personnel in engineering-contracting firms will be covered. Such copies will be provided without charge, postage prepaid. (Recipients will pay customs charges, if any, outside the U. S. A.)

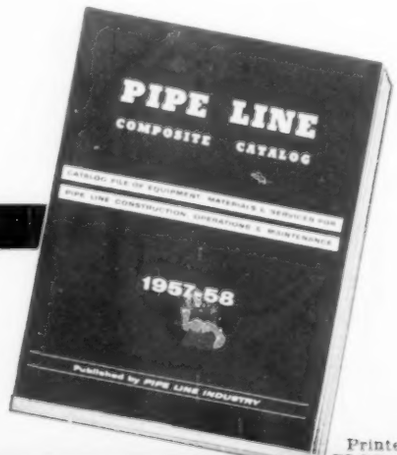
Letters soliciting these names for distribution (without charge) will be mailed to pipe line companies and contractors at the proper time, before mailing date.

Orders for prefiling now being received

Orders for the prefiling of catalogs in the new PIPE LINE COMPOSITE CATALOG are now being received. Pictured above is President J. S. Downs of the W-K-M Manufacturing Company, Inc., Houston, signing the first order for the prefiling of a pipe line equipment catalog (40 pages) as Advertising Manager, Russ Hunt, looks on. W-K-M has heretofore filed a condensed catalog of pipe line equipment in the COMPOSITE CATALOG OF OIL FIELD AND PIPE LINE EQUIPMENT. (The company will retain its catalog of drilling-production equipment in the COMPOSITE CATALOG OF OIL FIELD EQUIPMENT.)

The new W-K-M pipe line equipment catalog will contain 40 pages of material on its through-conduit and venturi pipe line valves, including engineering specifications, weights, types and dimensional information.

Manufacturers of pipe line equipment may have full information by writing:



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is mounted at the outer portion of the box.

There are three primary sealing points (Figure 3) in mechanical seals: (1) between the stationary element and the casing; (2) between the rotating element and the shaft or shaft sleeve; and (3) between the adjacent surfaces of the rotating and stationary elements.

Conventional gaskets, or synthetic rubber "O" rings are generally employed to stop leakage between the stationary element and the casing. Synthetic rubber "O" rings or bellows and fluorocarbon wedges or cups are most commonly used to stop leakage between the rotating element and the shaft or shaft sleeve. (Leakage between the shaft and the sleeve must be stopped if the seal is mounted on a sleeve.)

Leakage between the adjacent faces is controlled to insignificant amounts by the very close contact possible between these faces. Contrary to popular conception, mechanical seal faces do not stop leakage since it would be impossible to do so and still obtain a pressure breakdown across the seal faces. In actual operation a negligible flow will produce the desired breakdown across the faces and will simultaneously maintain a thin film of liquid between the faces. This thin film of liquid acts in the same manner as an oil film in a bearing and keeps seal face wear within economical limits. The principal problem in sealing volatile liquids, which are generally poor lubricants, arises from the need to maintain this liquid film.

How the Seal Operates—The fundamental functions of the various seal parts will show how the seal operates, and will also give their relationship to the successful performance of the complete seal.

Flexibility . . . conpensates for tolerances, wear, deflections, and to some extent erratic shaft operation. To do this the spring (or springs) must be in good shape and free to adjust. Seal movement cannot be restricted, as any members which are seated by the spring action must have freedom of motion. One of the most troublesome problems in seal application is maintaining this freedom when the liquid has particles in suspension, or has a tendency to deposit crystals

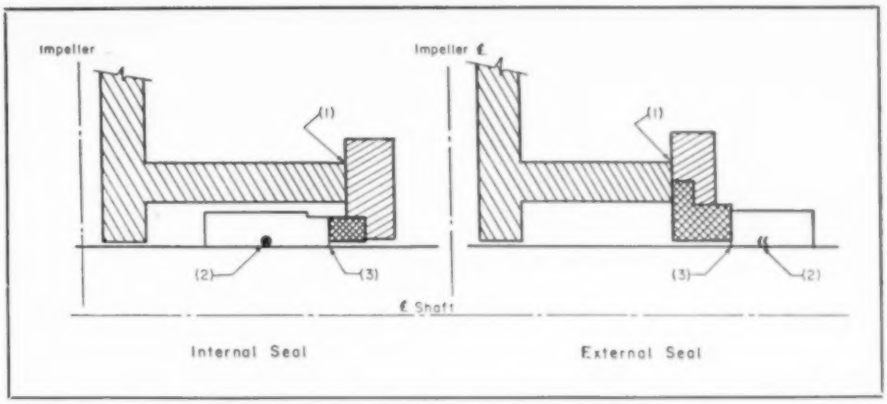

FIGURE 3—The three sealing points in mechanical seals.

or plate out on seal parts. Another source of difficulty comes from mounting the seal on a surface that is scored or out of round resulting in erratic action or binding.

Also important to flexibility is the proper amount of initial compression to provide sufficient seating force for the parts that are guided by the springs. Initial compression is obtained by following the seal manufacturer's axial dimensions in setting the seal. Incorrect dimensions will either result in too little initial compression, with the danger that the seal faces will pop open, or in too much compression which causes excessive wear.

The matter of correct initial compression is especially important with an external seal, since this type generally relies solely on spring pressure to keep the seal faces together as contrasted with the internal type where liquid pressure helps to seat the faces.

Sealing Against Leakage at Static Points . . . whether "O" rings, bellows, or fluorocarbon materials are used, they must be free from nicks and tears and be properly sized. Remember that these parts compensate for machining tolerances and clearances between separate pieces, and therefore must be suited to the mating part dimensionally in order to stop leaks. Also it is extremely important that the surface of the shaft or sleeve be in first class condition to insure good contact at these sealing points, and not cause binding.

The stationary element must be at right angles to the shaft, meaning that the face of the stuffing box must be square, the gland material must be sufficiently rigid to avoid distortion, and the gland bolts size and location must be adequate to securely position the gland. The gasket thickness should be carefully chosen as unequal compression on thick gaskets can cause distortions. A nominal maximum of 1/16-inch gasket is desirable.

Sealing Between the Stationary and Rotating Parts . . . this point commonly known as the "seal faces" is the focal point of mechanical seal operation. When the seal faces fail excessive leakage results, and the parts must be repaired or replaced. Initially, the seal faces are highly polished and perfectly flat.

In the course of operation, the two parts become "mated" in any irregularities of wear and therefore upon disassembly should be relapped to the original condition or replaced. Satisfactory sealing action can be maintained as long as the faces remain in intimate contact and are sufficiently smooth to sustain a thin film of liquid between them.

Seal Selection—It has been noted that the principal sealing effect is obtained by the extremely close contact of the two seal faces, separated by a thin film of liquid. This is analogous to sliding friction, and drawing from that analogy we know that the resistance to motion depends on the character of the film between the two bodies and the load that is pushing them together. Thus with mechanical seals the nature of the liquid and the pressure to be sealed determine the type of seal which is best for the job.

With the internal type of seal the pressure in the stuffing box tends to

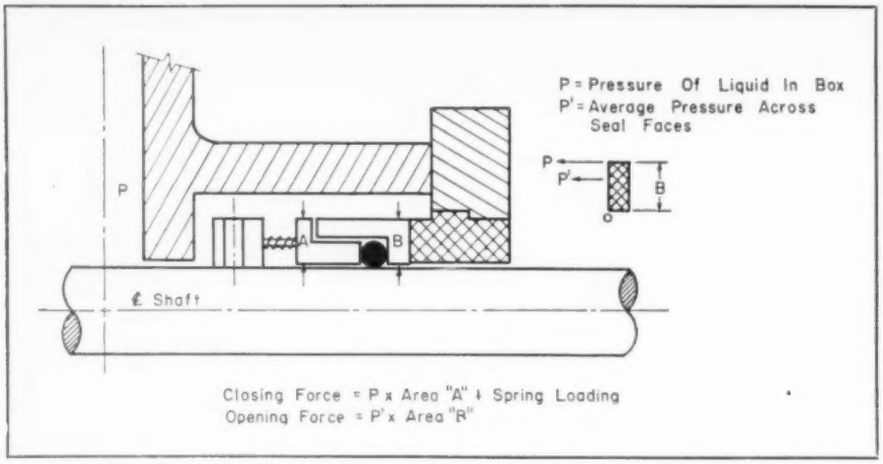

FIGURE 4—Area relationships for unbalanced seal construction.

keep the seal faces together, and this is the loading we are concerned with. The simplest design of seal is such that the entire pressure acts to close the faces. This type is satisfactory as long as the liquid handled is able to sustain a thin film between the faces under these loading conditions. In other words, as long as the liquid is a good lubricant high loads on the seal faces are not troublesome.

Such seals are known as the "unbalanced type" (Figure 4), and experience has indicated that 100 to 150 pounds per square inch gage is the maximum practical stuffing box pressure for economical service when the liquid has lubricating qualities equal to, or better than gasoline. A refinement of this basic design proportions the seal areas so that only a predetermined percentage of the stuffing box pressure becomes load on the seal faces. These seals, known as "balanced seals" (Figure 5), by controlling seal face loading make less stringent demands on the lubricating qualities of the pumped liquid. The balanced seal is the logical choice when handling volatile liquids or solvents. Balanced seals are widely available for working pressures up to 700 psig, and certain types are usable to considerably higher pressures.

An overlapping pressure range exists between 50 and 100 psig in which both balanced and unbalanced seals are usable for many applications. The choice between the two is usually dictated by costs or standardization considerations. The unbalanced design is generally most desirable below 50 psig, since this pressure represents the lower limit for best operation of most balanced seals.

The identifying characteristics of external seals is that the rotating element is outboard of the stationary element. In most cases the seal is mounted completely outside of the stuffing box, but it is possible to recess the unit within the box for some special service conditions, or when space limitations make it necessary. The position of the rotating element with respect to the stationary element means that liquid pressure acts to separate the faces, and with an unbalanced external seal the only restraining force comes from the seal spring compression. This fact limits the upper pressure limit for this type of seal to approximately 30 psig. Balanced external seals are available which are applicable up to 100-150 psig stuffing box pressure.

The external type of seal is ideally suited to services handling corrosive or abrasive materials since the flexible members are out of the fluid being pumped. This eliminates one major source of trouble, and proper choice of seal face materials and modifications can extend the life of the wearing faces to economical limits. The modifications generally are designed to protect the faces against abrasives, and the actual arrangement used depends on the operating conditions. In these situations, field experience is the best guide to the most satisfactory type of assembly.

Installation Precautions—When handling clean liquids with good lubricating qualities at reasonable temperatures and pressures, seals can operate for several years without difficulty. Unfortunately, the most critical jobs do not offer such favorable circumstances and we must contend with dirt and grit, precipitates or crystals, volatile liquids, and with various extremes of temperature and pressure.

In regard to dirt and grit, it is needless to say that all extraneous foreign material should be eliminated to prolong the life of the pump as well as the seal. In those cases where the entrained material does become a serious problem certain corrective measures can be helpful. Flushing the stuffing box with clean liquid will prevent the particles from settling out on the seal parts and impairing operation.

This flushing can be accomplished through a suitable tap on the seal gland or through the seal cage connection. In most cases it is desirable to use an external source of clean liquid from some other compatible plant stream, but a line from the

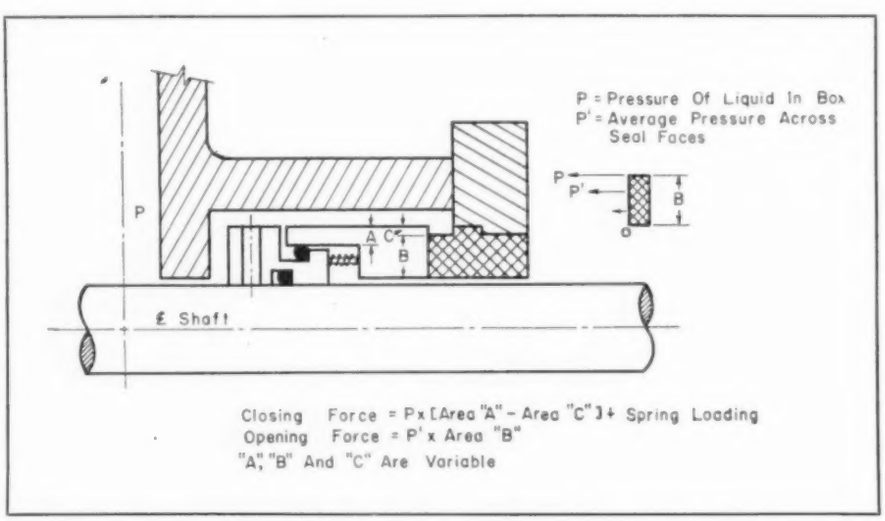

FIGURE 5—Area relationships for balanced seal construction.

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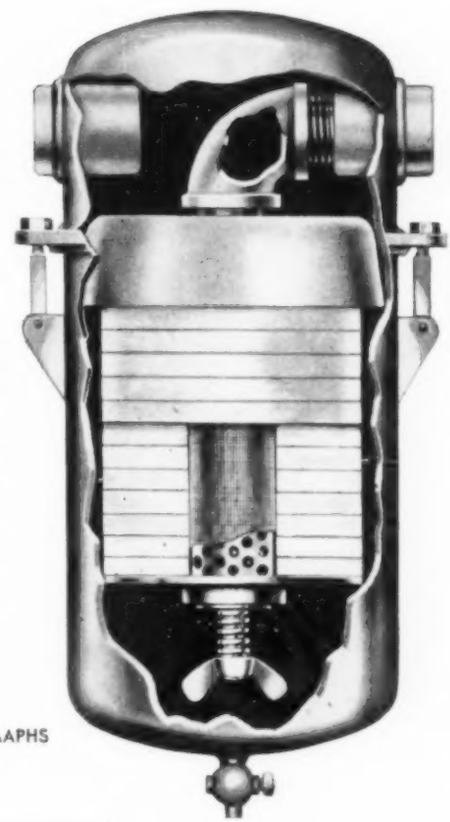

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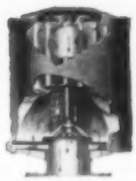

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pump discharge has proven effective when the primary necessity was to keep the foreign matter in circulation. It should be noted that the extremely fine particles are the most troublesome, as they are the ones that can get between the seal faces and cause rapid wear.

Returning to the analogy between seal face action and sliding friction, it is recalled that such a situation promotes local heating at the point of contact. The same thing is evident in seal operation and is a potential source of trouble when the stuffing box pressure is near the liquid vapor pressure. The addition of heat to the liquid at the seal faces can cause local flashing. The net result is that the seal is exposed to intermittent periods of handling gas with obvious impairment of the film between the faces. Consequently, seals operating under such conditions can be prone to frequent and unpredictable failure.

An effective remedy is to maintain a definite circulation of liquid around the seal to remove the heat generated at the seal faces. This is most easily accomplished by connecting a line from the pump discharge to the seal space which will induce circulation past the seal and back to pump suction.

This line often called a recirculation line and also a flushing line, is an essential feature on vertical pump installations. In this case the line connects from the gland to the suction side so that pressure in the seal housing can be maintained high enough to prevent flashing. The line also serves to vent any entrapped vapors in the seal housing on start up. Pump and driver alignment and condition of driver bearings are vital factors to consider for successful operation of seals in vertical pumps.

Conversion of pumps in the field from packing to seals can, in most cases, be done without difficulty. Of necessity sleeve or shaft surfaces that have been damaged must be renewed before the conversion can be successful. It is also important to inspect the face of the stuffing box to make certain that the gland can be made tight at this point. Many of the older pumps were not finished at the face of the box, and even the newer ones have been corroded by quenching water at this point so that refacing was necessary. It is also advisable to check the bearings and eliminate any excessive play.

Two important factors in successful seal applications are often overlooked. The first is that any inquiry which involves a mechanical seal should have complete conditions of service. This is the only way you can be assured of procuring the proper equipment, and also availing yourself of the seal vendor's best recommendations for installation. The second is that all personnel responsible for the installation and maintenance of seals should be familiar with the manufacturer's recommendations. This information is supplied with standard instructional data, and for tough services additional special instructions are usually furnished.

Seal Materials—Metallic parts for mechanical seals should be selected on the same basis as other wetted parts. That is, if the liquid being pumped dictates stainless steel, the seal parts should be of an equal or better grade of stainless; where all iron or all bronze pumps are needed the seal parts must be compatible with the pump parts. Field experience plays an important part in the evaluation of proper materials, and the user can benefit from past experience of pump and seal manufacturers by giving complete details on the liquid to be sealed.

The operating temperature and the possibility of chemical attack must be considered in the selection of synthetic materials for seal rings and gaskets. In general, synthetic rubbers are satisfactory between —30 F and +200 F in liquids compatible to synthetic rubber. The incompatible liquids can cause deterioration marked by brittleness, swelling, or complete dissolution. The temperature range for fluorocarbon extends approximately from —120 F to +450 F, and it has been proven that fluorocarbon is resistant to attack by practically all liquids pumped in industry.

Since fluorocarbon does not have the resilient characteristics inherent in synthetic rubbers, seals employing this material are modified in design to provide a positive element to spread the fluorocarbon members. This fact plus the higher cost of fluorocarbon makes seals using this material more expensive than the synthetic rubber "O" ring or bellows type of seal. The price factor becomes more important in the pressure ranges above 90 psig.

Seal face materials are vitally important to successful seal application. There are numerous combinations employed which depend on the severity of the service and the justifiable cost ranging from the inexpensive general service seals, using cast iron and carbon faces, to the specialized combinations of ceramics, plastics or high alloy stainless steels.

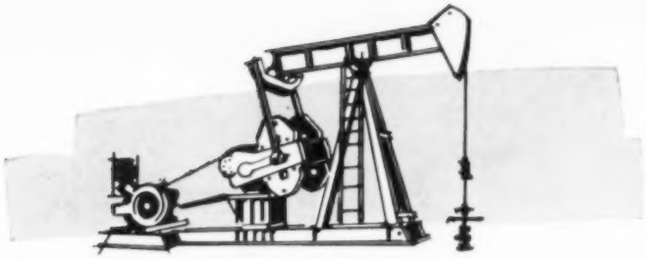
Hard faced stainless steel versus carbon is the combination used for the majority of applications. Seals designed especially for corrosive conditions often used a hardened alloy insert for corrosion resistance. Seal faces made of special plastics or ceramics are available for corrosive conditions detrimental to alloy metallic parts.

The guiding principle in the selection of materials is the fact that seal faces must permit intimate contact and be sufficiently smooth to sustain a film of liquid between them. Any operating condition which destroys this relationship would cause trouble and indicate the need for different methods.

The progress made to date in seal designs and materials has encouraged widespread use of mechanical seals. A fundamental understanding of seal functions will further this trend, and also assure maximum benefits from their use. —**The End**

About the Author

TED J. SNIFFEN, with Worthington Corporation since 1949, has held a variety of positions in the company's research and development activities and in application engineering on utilities and process pumping requirements. He is now stationed in Houston, where he gives technical assistance to the company's sales force. A professional engineer in Texas, Sniffen holds a mechanical-engineering degree from Newark College of Engineering.



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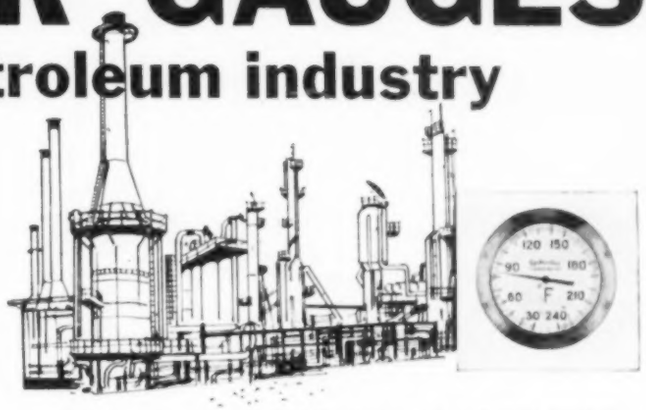

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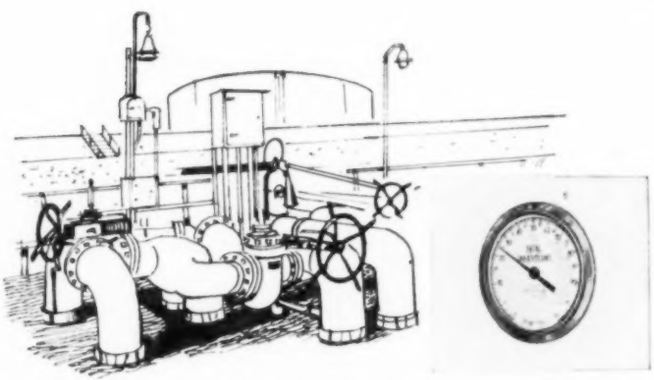

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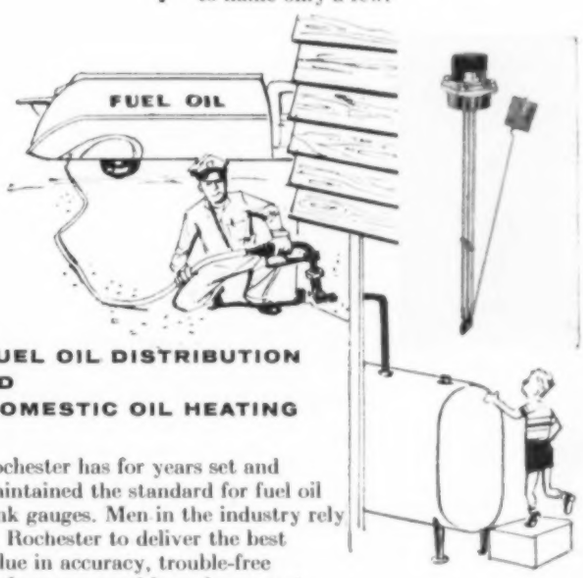

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Are You a Good Supervisor?

Merit rating programs are modern industry's insurance against appointment of employes who lack supervisory ability. Can you make the grade? Check yourself on the self-analysis chart.

By ROBLEY D. STEVENS
Management Consultant, Washington, D. C.

ALL COMPANIES—large and small—are concerned with cost. An improperly trained and rated supervisor can be costly. This fact has been increasingly appreciated by employers in our American free enterprise system. It's a rare thing now to find an organization which considers its supervisory positions in the light of rewards for dogged, faithful service. A systematic, purposeful approach to filling supervisory jobs seems to be the rule today.

In brief, the approach implies three steps:

- A thorough study of the particular supervisory jobs involved.
- Determination of the characteristics of individuals which best meet the needs of the jobs.
- Establishment of a valid and practical way to find out which individuals have these characteristics to the most desirable degree.

Supervisory rating programs which fulfill these requirements pay dividends. Actually they will turn up supervisory talent which otherwise would never have been recognized. Even in a small oil company persons with good supervisory potentials are overlooked. In large firms the risk of this is substantially magnified. And, the program will spotlight talent obscured by one or another of the above factors.

Experts in management will tell you that a merit rating program for supervisory personnel is an insurance policy against the appointment of persons who can't make the grade as supervisors.

Also, the program bolsters workers' morale in two ways:

The knowledge that a definite merit rating program is in effect relieves the anxiety of workers that they may not get the recognition they might merit and that others, less worthy, may get preferment. And it salves the wounds of workers disappointed in their expectations of a promotion to know that their abilities were considered, that they didn't lose out because somebody "had it in for them," and they can try again for the next supervisory opening.

A merit rating program for supervisory personnel speeds up the process of filling vacancies by an advance evaluation of persons who are eligible so that all the preliminary work is finished and available when a selection must be made. This realization has resulted in a more careful selection of supervisors.

Recent studies by management experts generally indicate that today oil companies look for the following qualifications in supervisory personnel: Leadership ability, organizing ability, character, judgment, technical skill and mechanical ability, education, initiative, human interest and physical and mental requirements.

Many companies generally try to find people within their own organization who can be promoted to the position of supervisor whenever a vacancy occurs. They seem to do this because it has a definite bearing on the growth and development of supervisors. More and more skilled workers are looking for jobs that offer career opportunities, and as long as an oil company holds to the policy of promotion from within, workers feel that their present company offers career possibilities.

The first step in any merit rating supervisory program should be a job analysis. Yet in the analogous situation of selection and rating of supervisors, there is a great temptation to try to fill the job without knowing anything more than that a supervisor is wanted. It is true that all supervisory jobs have some common elements, but it is important to recognize that no two supervisory jobs are identical and that, in some cases, the differences are as important as the similarities.

In the most inclusive possible terms the job of every oil company supervisor is to get out production. A correlated objective is that of seeing that his subordinates obtain job satisfaction. The supervisory job consists of a multitude of duties subordinate to these fundamental ones. But even more than that, the supervisor in every company is responsible, too, for interpreting management policies and programs to the subordinates and for giving these policies and programs his full support.

In addition, supervisors are the worker's "pipe line" into management. Workers' suggestions and complaints that fall to management are

Meet the Author

ROBLEY D. STEVENS is a Washington correspondent and management consultant specializing in public-labor-personnel relations. He is a former representative of the Labor Department and was connected with the Army and Navy departments in civilian capacities. He is author of two books on labor relations as well as a number of magazine articles in that field. Stevens holds both LL.B. and LL.D. degrees from Blackstone School of Law.

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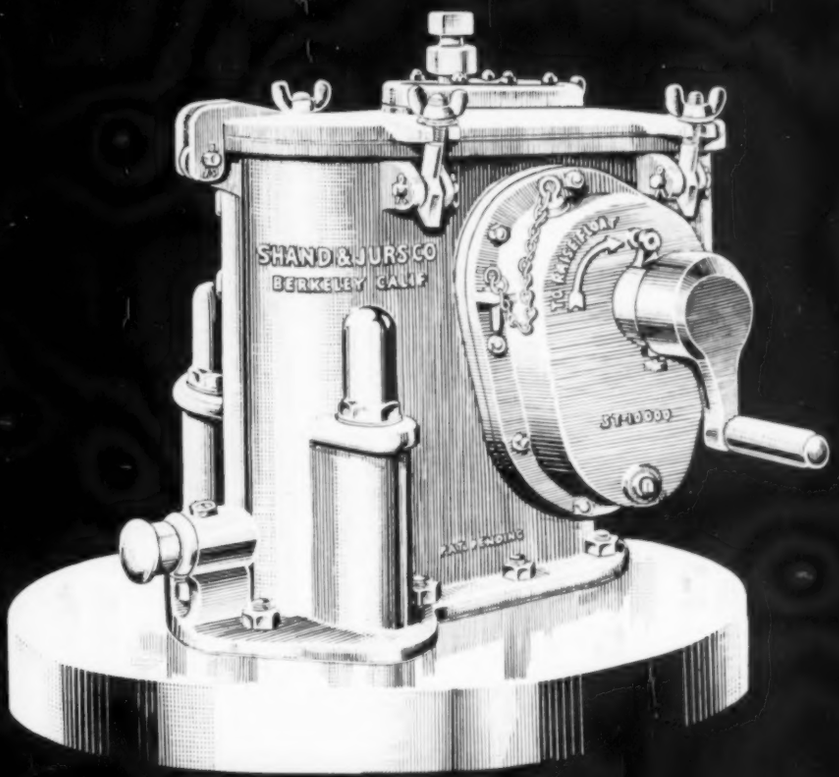

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usually transmitted through the supervisor. And, of course, the supervisor has the clear responsibility of setting a good example to his subordinates in his own work conduct, attitudes, and actions. He must act in such a way as to improve morale and decrease friction among the subordinates. Hence, when a supervisor in your company is "improving morale," he is really improving his performance in one of the basic supervisory duties.

Management will find that there are differences between supervisory jobs which are based on the weakness or strength of the previous incumbent. The job of the newly selected and properly rated supervisor of a unit formerly piloted by a whip-cracking martinet is going to be a very different proposition from that of a supervisor taking over from an amiable incompetent.

It is recognized that the job of supervising generally operates most effectively when the supervisor devotes full time to this primary duty—supervision. In short, everything that an oil company supervisor does is an act of leadership. He leads by setting a good example. As long as supervisory positions exist, men must be selected and rated to fill them.

The necessity of job analysis and the primary characteristics that are required for most supervisory jobs have been described. The next question is: What formula to use in determining the needed skills of a supervisor? The answer to this would appear to be a statement of minimum qualifications as being highly important. Job analysis is extremely important in setting minimum qualifications. However, by careful delineation of the background and characteristics needed for a particular supervisory position, management can eliminate many undesirable persons.

A systematic supervisory selection and merit rating program is no panacea. Your management may be convinced of the need for it because of the large and expanding needs for competent supervisors, because of the greater effectiveness of such a program, or because of its morale advantages. To what positions and at what level should this program be applied depends upon your management. The program can be carried on formally or informally and administered by the personnel officer.

SUPERVISOR'S SELF-ANALYSIS

1. Understanding My Organization:

Do you know the functions of your department and how they contribute to the total policy of your company?

Yes ☐ No ☐

Do you show each worker how his job fits into the over-all picture?

Yes ☐ No ☐

Can you determine lines of authority and responsibility?

Yes ☐ No ☐

Can you determine number and type of workers required in your department?

Yes ☐ No ☐

Can you make logical duty assignments based on clear outline of responsibility and authority?

Yes ☐ No ☐

2. Getting the Work Out:

Do you give directions that are clear, understandable, and specific?

Yes ☐ No ☐

Do you review work for progress in meeting schedules?

Yes ☐ No ☐

Do you know how to coordinate the work of your department and take action as necessary?

Yes ☐ No ☐

Do you see that your workers do what is rightfully expected of them?

Yes ☐ No ☐

Do you constantly emphasize the control of cost?

Yes ☐ No ☐

Do you minimize the necessity of overtime work?

Yes ☐ No ☐

Do you resolve your production problems immediately?

Yes ☐ No ☐

3. Planning and Scheduling Work:

Do you keep up with the workload of your department?

Yes ☐ No ☐

Do you plan priorities of work and schedule accordingly?

Yes ☐ No ☐

Do you always plan for the best use of manpower, space, and equipment?

Yes ☐ No ☐

Do you establish realistic goals for your workers?

Yes ☐ No ☐

Have your workers participated in setting their own goals?

Yes ☐ No ☐

Do you plan to meet deadlines and emergencies?

Yes ☐ No ☐

4. Improving Working Methods:

Do you analyze operations of your department as a whole?

Yes ☐ No ☐

Do you evaluate present methods of performing jobs?

Yes ☐ No ☐

Do you develop and apply improved methods?

Yes ☐ No ☐

Do you encourage and assist workers in submitting their ideas?

Yes ☐ No ☐

CHART: *How Do You Measure Up?*

5. Determining Performance Requirements:

Can you determine what is expected of each worker?

Yes ☐ No ☐

Do you discuss tentative requirements with each worker concerned?

Yes ☐ No ☐

Can you make final determinations of requirements based on needs of management, supervisory experience, and workers' suggestions?

Yes ☐ No ☐

Can you evaluate objectively each worker's performance based on requirements?

Yes ☐ No ☐

6. Developing Workers:

Can you select the right person for the job?

Yes ☐ No ☐

Do you help workers make adjustments on new jobs?

Yes ☐ No ☐

Can you determine training needs of workers and suggest training by management?

Yes ☐ No ☐

Do you measure results of training in terms of production cost and improved skills, attitudes, and other factors?

Yes ☐ No ☐

Do you discuss career opportunities with workers?

Yes ☐ No ☐

Have you developed an understudy?

Yes ☐ No ☐

7. Maintaining a Cooperative Workforce:

Do you see that workers are rewarded for jobs well done in the company's interest?

Yes ☐ No ☐

Do you commend the entire group on performance when deserved?

Yes ☐ No ☐

Do you transfer and reassign workers for the best use of their abilities?

Yes ☐ No ☐

Have you earned the worker's confidence and loyalty?

Yes ☐ No ☐

Can you adjust differences fairly and objectively?

Yes ☐ No ☐

Do you keep the workers well informed on management policies?

Yes ☐ No ☐

Do you develop and maintain effective discipline among your workers?

Yes ☐ No ☐

Can you initiate corrective and penalty actions as needed?

Yes ☐ No ☐

Do you help to insure safety and welfare of the working force?

Yes ☐ No ☐

8. Self-Improvement:

Do you recognize your shortcomings?

Yes ☐ No ☐

Do you constantly improve your ability to get along with people?

Yes ☐ No ☐

Do you develop a cooperative relationship with your superiors, and other personnel above you?

Yes ☐ No ☐

Have you developed a good attitude toward your job and your company?

Yes ☐ No ☐

9. Miscellaneous:

Are you friendly, reserved or antagonistic toward your associates?

Yes ☐ No ☐

Are you highly cooperative, work hard, or non-cooperative in your job?

Yes ☐ No ☐

Do you respond positively, find fault or seek favors?

Yes ☐ No ☐

Do you adjust adequately to changes in duties or working conditions?

Yes ☐ No ☐

Do you keep abreast with latest developments, show initiative in making self-improvement, or are you shy and non-aggressive?

Yes ☐ No ☐

Do your subordinates like you personally?

Yes ☐ No ☐

Do you need more supervisory training?

Yes ☐ No ☐

Do you accept, seek, avoid, or dislike responsibility?

Yes ☐ No ☐

If you answered "yes" to 25 of the questions, you are working together with others for more management power. In so doing you will manage your resources to get better results for your employer. —**The End**

Give 'Em a Chance to Grow

In developing manpower, top management must eliminate these four dangerous pitfalls:

- **Treating an employe as a piece of equipment.**
- **Giving him benefits that he doesn't merit.**
- **Impeding the employe's self-development.**
- **Ignoring his need for recognition.**

By WILLIAM E. BRIGHT, JR.
Chairman, Committee for Employe Development
The Pure Oil Company, Chicago

IN THE PAST decade few industrial needs have commanded more attention than that of planning for the orderly development of personnel. This has become necessary because of the growing feeling of insignificance on the part of the worker, resulting from the continued growth and mechanization of industry. Now, however, management in many companies has begun to recognize more fully the employe's human needs.

There are three main forms this management recognition has taken. Each derives from a different management philosophy.

In the first, management takes a reluctant, negative approach. It feels it is yielding prerogatives and profits to the employe's unreasonable demand for ever-greater consideration. Such a management seldom gains any increase in productivity for the "prerogatives and profits" it spends. And this, of course, seems to management, to justify its negative point of view.

The second approach is simply modern paternalism. Management graciously yields to the inevitable, hoping thus to buy loyalty at the expense of installing one employe benefit plan after another. Until finally, all of its spineless employes are lethargically "secure," its average employes are "spoiled" and those with enough initiative to become capable managers have all resigned.

Both these approaches to employe relations treat this function of management as an expense. Quite as if maintaining morale were like maintaining equipment. When profits contract so does the employe relations budget.

There is, fortunately, a third alternative. This approach interprets the employe's growing demand for significance in the enterprise as evidence of his desire to earn the increasing satisfactions he seeks. To treat him as part of his machine will breed frustrations that impair his productivity. To give him anything he does not merit will destroy his initiative. To impede his self-development will lessen his potential usefulness to the organization.

What he really wants, this management believes, is to work in an environment that provides maximum opportunity for him to produce and grow. Given this he can in most instances be expected to become continually more useful to both the company and himself.

The third approach, unlike the others, does not identify employe relations as an expense. Instead it becomes a means for improving efficiency, productivity and the supply of replacements for managers at all levels of the organization. When profits fall employe relations is one of the functions management looks to for help in rebuilding them.

Without this third point of view it is futile for a company to go through the motions of personnel development. To do so can only damage the organization. It is both more honest and resultful for such a company to admit that it prefers to live in the 19th Century. Management might much better openly declare it believes in unguided experience, the intuitive selection of managerial personnel, and a primitive form of the "survival of the fittest." Then its young men who believe that the horseless carriage is here to stay may seek a less antiquated environment elsewhere.

Psychological Conditions of Work—There are two ways to get to the top of an oak tree. You can either climb the tree . . . or sit on an acorn. In Organizational Development the choice is limited to the second alternative.

All management can do is create the kind of work environment conducive to self-development and then let nature or the natural motivations of man take over.

If a proper atmosphere or work environment is all we can hope to achieve let us examine its nature. What is this environment that stimulates individual initiative and provides maximum opportunity for its exercise?

George Elton Mayo, in his famous experiments at the Hawthorne Works of the Western Electric Company between 1924 and 1927, demonstrated

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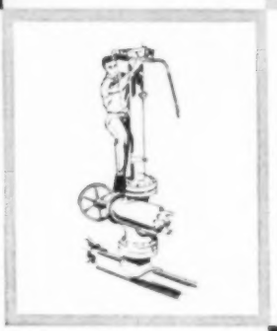

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that a strongly motivating environment does not stem from the physical conditions in which work is performed. He discovered, according to D. C. Miller and W. H. Form in "Industrial Psychology"—"something which increased output no matter what was done about physical conditions."

Mayo started out to test the effect improved physical conditions of work (better lighting, rest breaks, etc.) have upon productivity. His experiments backfired. One group, used just to get a comparison and for whom no "improvements" were made, matched the increased output of the employes whose environment was physically improved.

So Mayo began taking away the physical improvements given to his test group, and—to his surprise—the output kept right on going up.

Since 1927 this experiment has several times been repeated with similar results. By elimination of alternative causes, it has been demonstrated now that the main reason for the improved output in these experiments is psychological.

The test employes felt more important because of being included in the experiment. They felt they were expected to develop improved performance. So this is exactly what they did.

For the first time each test employe felt like "a partner in the business." As if his work were really important. As if management were asking his advice and aid in improving the operations of the company. As if he were "participating" in the management of his own work. It is no longer "surprising" as it was to Mayo in 1927 that productivity improved.

The most significant aspect of the fully motivating work environment is a continually demonstrated desire on management's part to have each employe participate in making the business successful.

Peter Drucker calls it "management by objectives." Others describe it as "participative" or "consultative" management. By whatever name, it involves delegating to each employe every authority and responsibility he is capable of exercising . . . and it takes a very generous view of his capabilities.

Perhaps even more significantly, this kind of managing requires management to have infinite confidence in the good intentions of its employes.

MODERN MANAGEMENT MEETS EMPLOYE NEEDS IN THREE WAYS:

1. *The reluctant, negative approach.* Management feels it is yielding prerogatives and profits to the employes' unreasonable demand for ever greater consideration. Employe relations is considered an expense.

2. *The paternalistic approach.* Management graciously yields to the inevitable, hoping thus to buy loyalty at the expense of installing one employe benefit plan after another. Employe relations is considered an expense.

3. *The approach which provides an environment for the employe to produce and grow,* with three objectives in mind: To improve efficiency—to increase productivity—and to supply replacements for managers at all levels of the company. Employe relations is *not* considered an expense.

IN WHICH CATEGORY DOES YOUR COMPANY BELONG?

Without respect for the individual merit and confidence in the honest intentions of employes, it is inconceivable that a management could practice consultative managing.

There is another interesting way to view this situation.

Sometimes managers have told me their men are stupid and untrustworthy. In saying this they also tell me what their men think of them.

Companies frequently conduct opinion surveys to discover how employes feel about the company and its management. Such surveys are usually worthwhile for their many indications of specific employe needs. But for the purpose stated—to discover how employes in general feel about their work and management—no elaborate survey is actually required.

All any manager, who wants to find what his men think of the company and of him, has to do is survey his own opinions of his men. When he has set down exactly what he thinks of his men, he has an accurate record before him of what they think of him.

For respect and confidence are reciprocal. If he believes his men are competent, they will respect his judgment as a manager. If he trusts their motives they will have confidence in him. If he underrates their ability and is suspicious of their motives how can they possibly feel any other way about him?

Do you and I trust people who have no confidence in us? Do we respect peoples' judgment when they have a poor opinion of ours?

Literally, whatever the manager's expectations of his men are, they are quite likely to be fulfilled. And this may be extended to the expectations an entire management holds for the whole organization.

The keystone in any program of Organizational (or personnel) Development is an attitude of trust on management's part in the merit and motives of employes that will facilitate "managing by objectives." The kind of managing that encourages maximum participation by the employe in the direction of his own work.

"Everyone Is Queer But Me and Thee"—What are the psychological needs such an environment can hope to satisfy in the individual employe? Why does he work and grow most beneficially in a psychologically satisfying atmosphere?

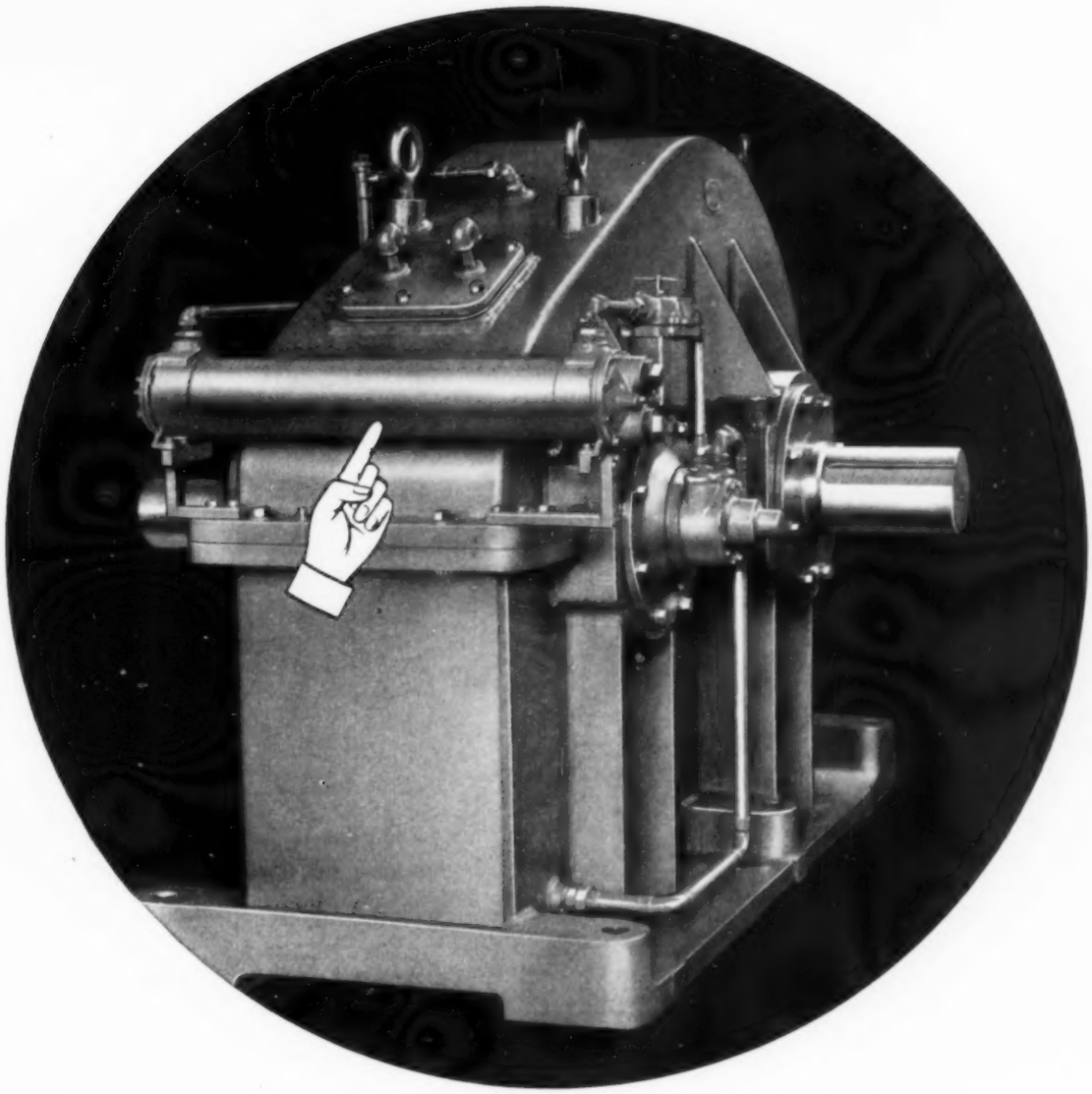
A group of supervisors attending a session of the Industrial Management Institute at the University of Wisconsin were given a list of 10 things employes want. They were asked to rank them not on personal significance but to indicate their estimated importance to the employes.

Two items on the list of 10 were, of course, "good wages" and "job security." The Wisconsin supervisors said these two items were most important to their employes.

Then they viewed the results of an opinion survey in which 10,000 workers ranked these same 10 items; they also saw how the immediate superiors of these men ranked the items for appeal to workers.

The Wisconsin group and the immediate superiors of the 10,000 workers were in close agreement as to what employes want. Both were in almost complete disagreement with what the 10,000 employes themselves said they wanted.

Do you suppose this convinced the Wisconsin group of supervisors they ought to re-evaluate their understanding of the things their employes want? On the contrary, they insisted the



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findings of the survey must be wrong. It was called to their attention that most of the many similar surveys made over the years support the ranking the 10,000 workers made.

The group still insisted they were right and all the surveys were wrong.

Someone pointed out that labor union demands—with their stress of higher wages and greater seniority rights—"prove" these are the things employes want most.

Subsequent discussion indicated, however, that the group felt the union does not always accurately represent the wishes of the individual employe, that it has interests separate from his and that the union tends to express employe wants in a politically realistic, socio-economically acceptable form. The union needs a tangible record of accomplishment in its members behalf that it can point to with pride. Hence it sometimes adopts substitute goals.

It became clear that the group did not believe union leaders know what employes want.

You can see what an interesting situation this had become. These conclusions seemed inescapable:

- Employes *do not* know what they want.
- Unions *do not* know what employes want.
- Supervisors *do* know what employes want.

Even when these conclusions had been stated many of the supervisors held to their original conviction. Another evidence of how futile logic is when applied to an emotional situation. But, of course, these foremen were also misapplying logic themselves.

A Need Provides Motive Power—A consistent pattern of employe wants or needs has emerged from the dozens of competent surveys now available from universities, trade and industry associations and consulting organizations. If a company—or a manager—is aware of this pattern of human needs in an industrial setting it can work wonders in motivating its men to improved performance and realization of latent abilities.

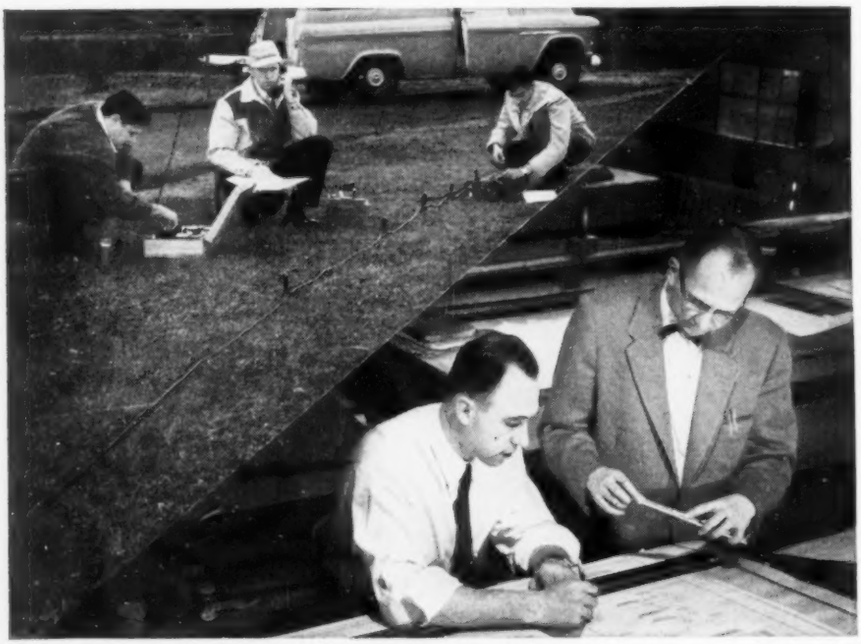
In a recent talk before an industrial group in Chicago Dr. C. H. Lawshe of Purdue University identified the needs that constitute the supervisor's motive power. His list is brief:

- The need for personal economic security.
- Opportunity for expression of individuality (including growth).

Dr. Lawshe then pointed out that the need for personal and economic security can be oversatisfied as well as unfulfilled. The most productive work environment is one in which a happy medium of "psychologically adequate" security exists. He describes this as one in which:

- Wages and physical working conditions compare reasonably with national and local standards.
- The employe is recognized as a unique individual.
- He understands his duties, company policies, significant changes that affect him and how he is progressing on his job.
- Discipline is loose but clearly defined; firm but not restrictive.

The degree to which a work environment satisfies the employe's need



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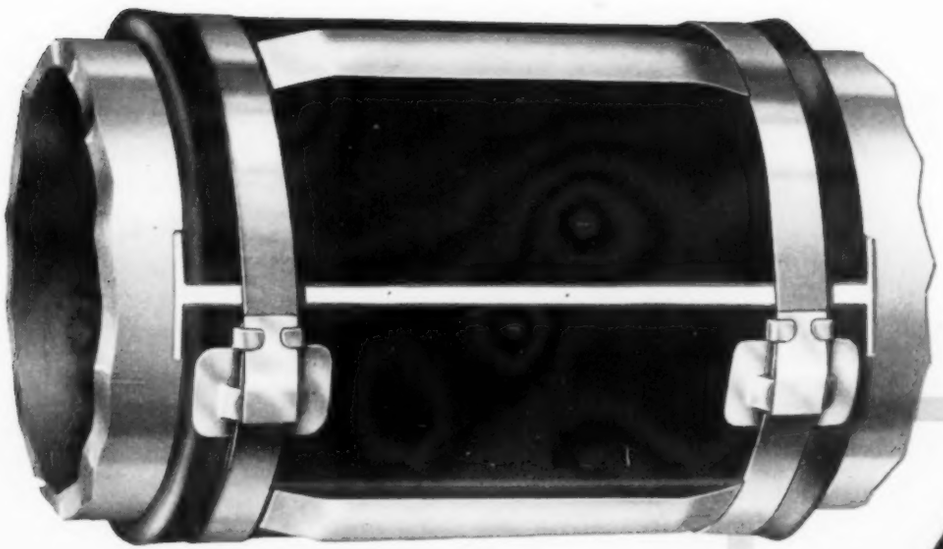
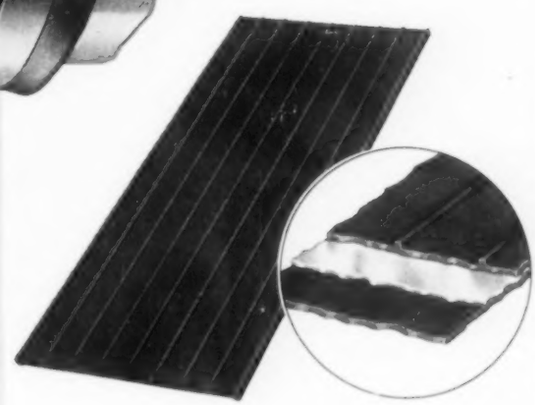


2" through 12"



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of an opportunity for self-expression can be described in terms of the psychological state the environment creates in the employe:

- Dependency, in which he is a kind of zombie.
- Reactive independence, in which he is frustrated and works against the company's interests.
- Creative independence, in which the employe identifies his own interests with those of the company and achieves maximum productivity and growth.

Looking at this from another perspective the work environment that is most stimulating to productivity and individual self-development is characterized by three major components:

- Participation of the employe in the management of his own work.
- Delegation of responsibility that is proportioned to each individual's emotional maturity and work experience.
- The opportunity to benefit from making mistakes.

So we have returned to the emphasis placed upon management attitudes and policies in the first paragraphs of this article.

Since management cannot effectively "command" employes to improve their productivity or self-development, the only alternative is for management to achieve a work environment that fosters these essentials to the company's success. Helping management to achieve the environment we have used excerpts from Dr. Lawshe's remarks to describe, is the goal of the personnel or organizational development program.

How Is This Environment Achieved? Such an environment, of course, is not achieved through formal training programs. Rather it stems from management's philosophy of operation, from company policies that express this philosophy and—even more significantly—from the example top management sets in its relations with middle management.

For actions still do speak louder than words and a subordinate determines his own behavior by analyzing the way his superiors handle their affairs—and him.

Whatever the specific projects that comprise an Organizational Development program, they are significant largely as tangible evidence of the management's interest in creating a work environment that promotes productivity and provides maximum opportunity—and rewards—for self-development of employes at every echelon of the organization.

There must be a firm conviction that the employe relations functions is not an expense. A belief, instead, that a sound personnel development program is today's most effective medium for improving the long-term profits of the enterprise. The company must realize that its most precious assets exist in the minds of its men. Their ideas, support and growth will determine the period and degree of the company's continuing success.

AUTHOR'S NOTE

Views and ideas contained in this article are based on the author's outside experience as well as upon his regular job but do not necessarily represent the stand of The Pure Oil Co. on the topics discussed.

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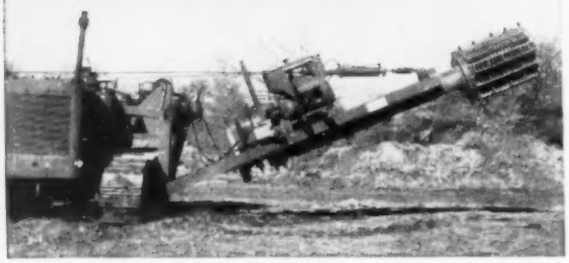

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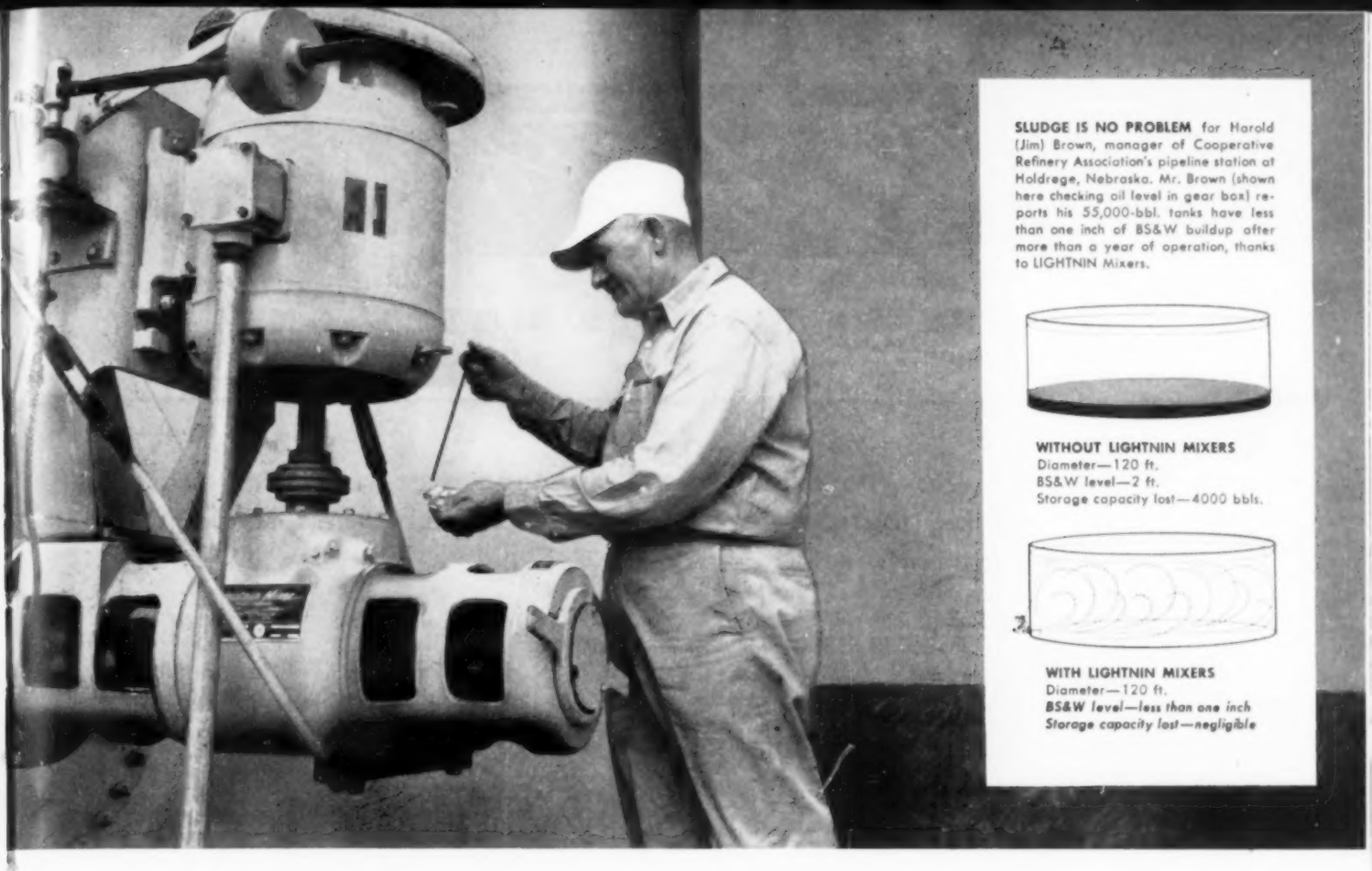

SLUDGE IS NO PROBLEM for Harold (Jim) Brown, manager of Cooperative Refinery Association's pipeline station at Holdrege, Nebraska. Mr. Brown (shown here checking oil level in gear box) reports his 55,000-bbl. tanks have less than one inch of BS&W buildup after more than a year of operation, thanks to LIGHTNIN Mixers.

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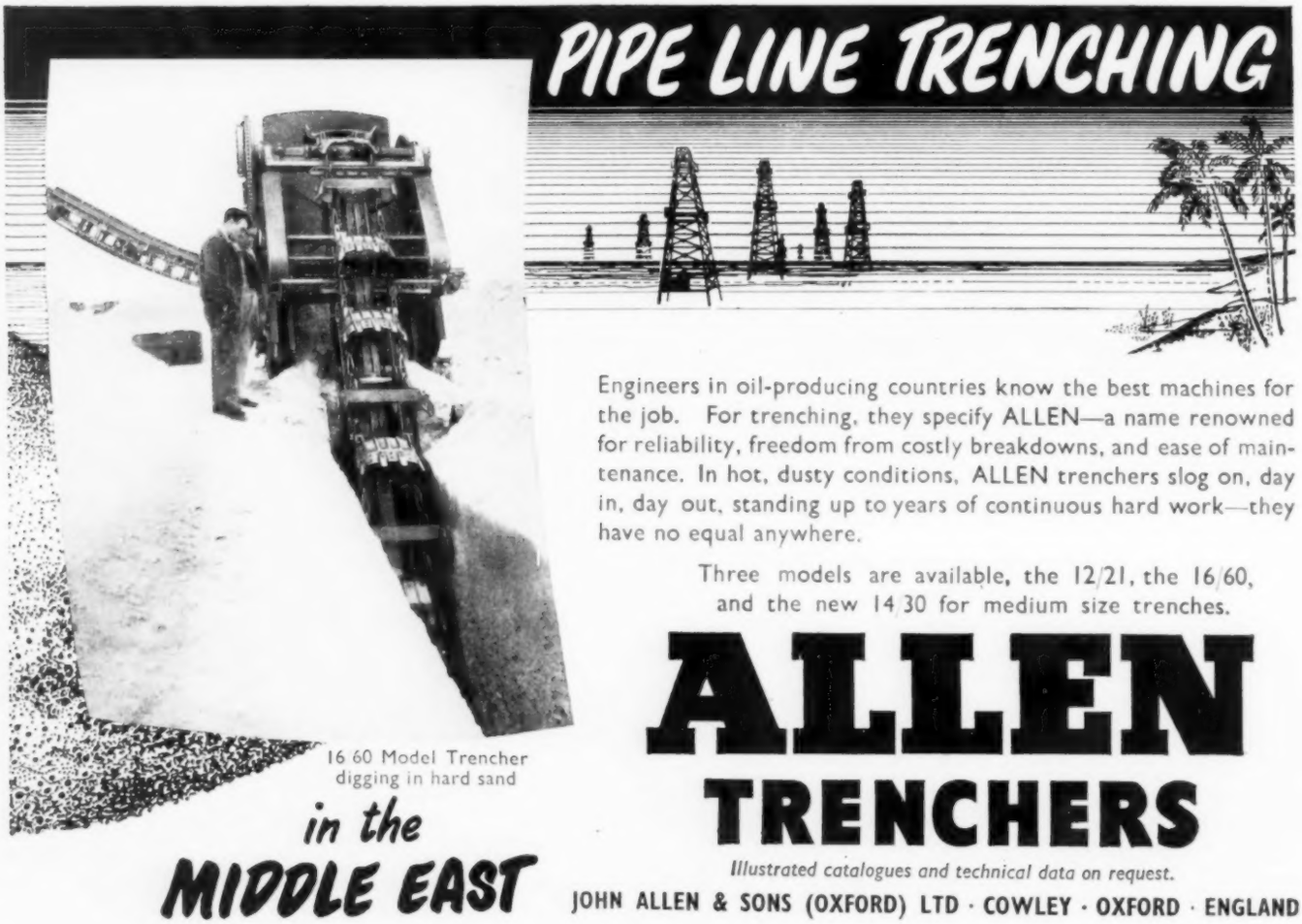
Average differential for runs remaining in service (A) =

$$\left[\frac{(\text{No. of runs in service})\sqrt{(\text{Average differential})}}{(\text{No. of runs remaining in service})}\right]^2$$

Example: A measurement engineer wishes to shut off one meter run on a four-meter parallel system to inspect the orifice plate. The average differential on the four runs is 49 inches and his meters have a 100-inch range. He wishes to determine whether shutting down one meter will over-range the three remaining meters.

$$(A) = \left(\frac{4 \times \sqrt{49}}{3}\right)^2 = (9.3)^2 = 86.5 \text{ inches}$$

Since the average differential for the remaining runs is 86.5 inches, the operator may safely shut the meter down as planned to inspect its orifice plate.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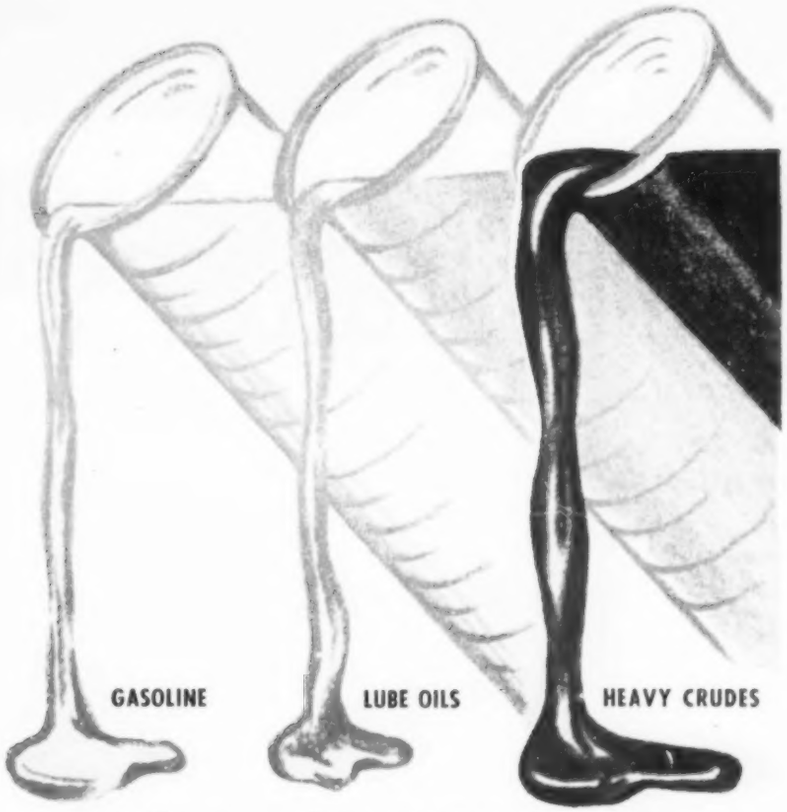

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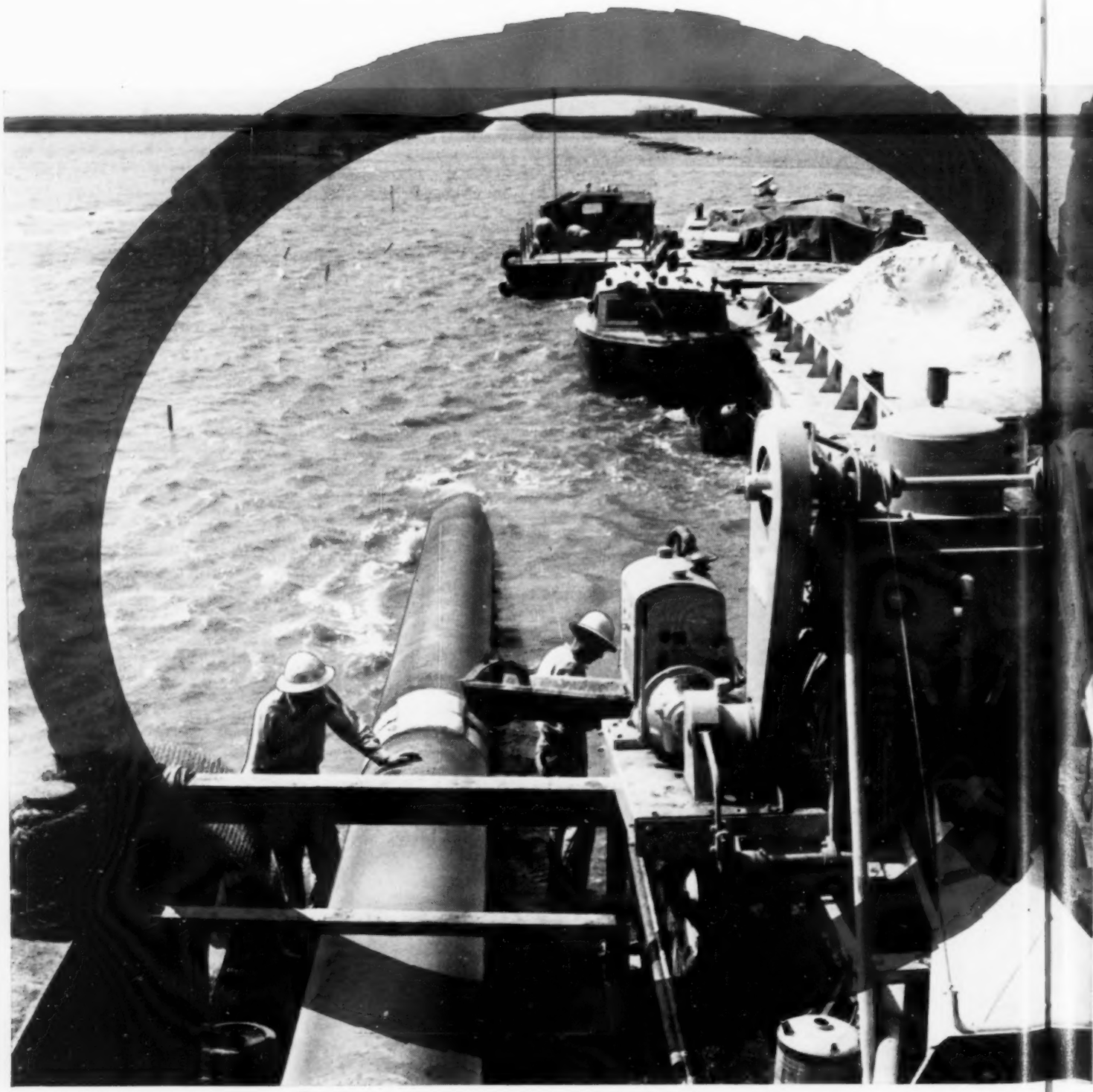

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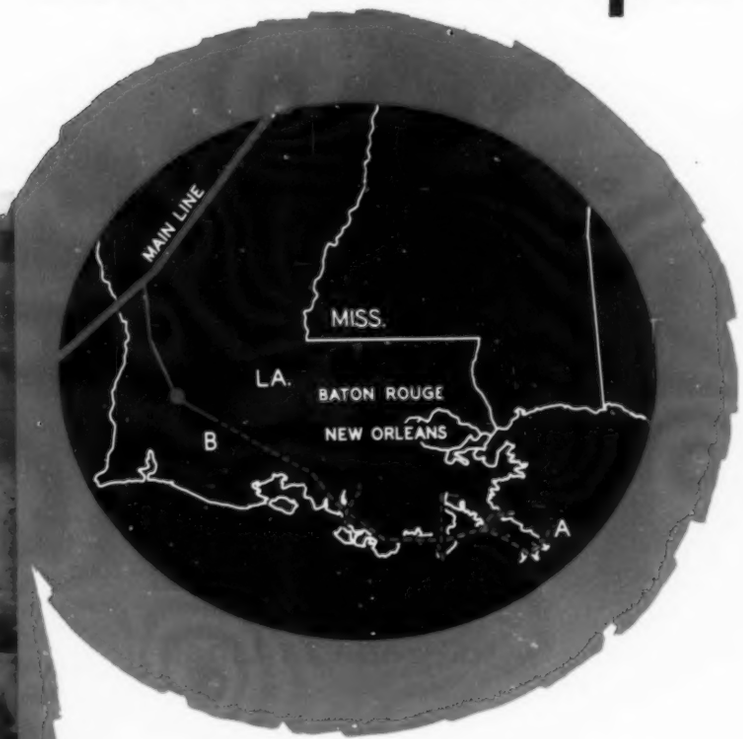

The "Muskrat Line", with its feeders, covers a total of 355 miles. From point A, off the Louisiana Coast, it runs generally westward across the Mississippi River Delta and along the Louisiana coast. And at point B (Crowley, La.) it hooks up with the existing gathering system. Only the last 70 miles of the line, before it reaches Crowley, involved normal dry land construction techniques.

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KERN INSTRUMENTS INC.
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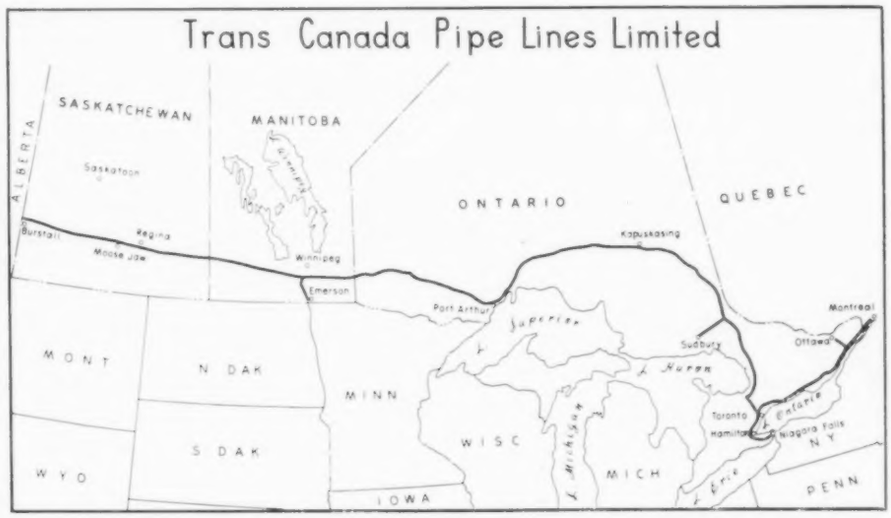
WHAT'S HAPPENING IN PIPE LINE CONSTRUCTION



Route of Trans-Canada Pipe Lines Limited's $378 million natural gas line. The section from the Alberta-Saskatchewan border to Winnipeg is scheduled for completion in 1956.

Contracts Awarded on Four Spreads, Work Begins on Trans-Canada Line

Contracts have been awarded for construction of four of the seven sections of the Alberta-Winnipeg leg of the Trans-Canada Pipe Line Ltd. $378 million natural gas pipe line project and work is underway. The long awaited start on this line was made possible by the Canadian Parliament's approval last month of an $80 million government loan to Trans-Canada.

The first four sections of the line will be built by Majestic Contractors Limited, Edmonton; Mannix Limited, Calgary; Canadian Bechtel Limited, Toronto; and Dutton-Williams Brothers Limited, Calgary.

Contractors for the first two sections of the line east of Alberta, Majestic and Canadian Bechtel, moved equipment on to the right-of-way and grading and other preparatory work began last week.

The 575-mile section of 34-inch line pipe is scheduled for completion to Winnipeg by December 1 to allow a month for testing. December 31 is the deadline for the start of deliveries of Alberta gas.

Steel for the western section, unavailable in the 34-inch size in Canada, is moving across Canada by freight in an almost continuous flow. Pipe for about 100 miles of the line is already stock piled. Each mile of line on the western Canada section requires 355½ tons of steel. The large diameter pipe is being produced by the National Tube Division of the U. S. Steel Company at McKeesport, Penn., and Orange, Texas, and by A. O. Smith Company, Houston.

The 1263 miles of 30-inch diameter pipe required for the section from Winnipeg to Toronto has been ordered from Canadian and British companies.

Plans for the 2250-mile line which will make natural gas available to one-third of the population of Canada for the first time have been in the making for five years. One of the longest pipe lines in the world, the Trans-Canada line will run from the Alberta-Saskatchewan border east-

The Caterpillar Engine in this Cleveland Ditcher has been working for more than four years, usually operating 14 hours a day. In all that time, Harford Bros., pipeline contractors of Emporium, Pa., have not spent a cent for engine repairs.

That's why Superintendent R. R. Mann reports: "We've found Caterpillar equipment *low on upkeep with plenty of power*. It's the best on the market for our work."

The D339 Engine is the modern successor to the D8800 in the Caterpillar line—with the same capacity for work and long life *and even greater power!* This new, smooth-running, compact diesel is a 140 HP engine (maximum output capacity). Like all Caterpillar Engines, it is a dependable four-cycle engine.

Balancers are standard equipment to give this powerful four-cylinder engine all the smoothness of six-cylinder performance. It has the famous tinker-free Caterpillar fuel system which allows the engine to idle for long periods without fouling even on low-cost, non-premium fuel.

Pistons, rings and rods in the new D339 are like those used in Caterpillar's field-tested V-type engines. Heat plugs, chrome-faced rings, cast-iron top ring bands give you thousands of hours of operation before inspection is necessary.

All these improvements spell dependability . . . keep the ditch ahead of the pipe. If a breakdown on any one engine can cause your entire spread to grind to a halt, make sure you're protected with modern heavy-duty Caterpillar Engines. See your nearby Caterpillar Dealer today for full particulars.

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Sawyer clothing also Rubberized or Oiled. Full range of jackets, pants, coats, hats, aprons for *more* efficiency, *more* economy, *more* protection on every job!

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ward to Montreal with branch lines running south from Winnipeg to the international boundary near Emerson, Manitoba, south from Toronto and north to Ottawa and Montreal.

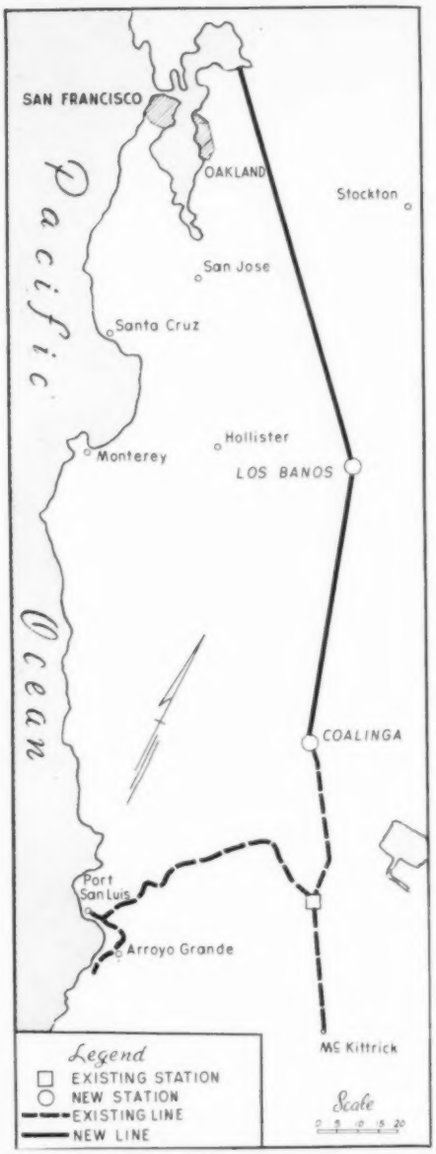
The bill providing for the government loan which made possible the immediate start of construction on the first leg of the line caused one of the most active debates in the history of the Canadian Parliament.

According to the loan agreement, the government provides 90 percent of the cost of the western section. This amount is to be repaid by Trans-Canada by March 31, 1957. After that time, if Trans-Canada is able to proceed with construction east from Winnipeg, the agreement covering construction of the northern Ontario section by the Crown Corporation takes effect. The provincial government of Ontario and government of Canada will build the portion of the line between the Manitoba border and Kapuskasing, Ontario, in conjunction with Trans-Canada's construction of remaining portions of the line between Winnipeg and Montreal.

The Toronto-Niagara lateral now in service is carrying natural gas from the U. S. to the Consumers' Gas Company of Toronto. Consumers' Gas is building up a market in Toronto area in advance of arrival of natural gas from Alberta through the main pipe line. When the gas from Alberta arrives, the Niagara line will revert to Trans-Canada and will be integrated with the over-all transmission network, carrying Alberta gas into southwestern Ontario.

Trans-Canada has signed contracts for the purchase of all gas required for present market requirements. In addition, Trans-Canada has contracted to sell Tennessee Gas Transmission Company 200 million cubic feet of gas daily at Emerson, Man. TGT and its affiliate, Midwestern Gas Transmission Company, propose to build a 1112-mile line to import this gas and sell it through the Midwest. (See PIPE LINE INDUSTRY, April, 1956, page 58. June, 1956, page 66.)

Ownership in Trans-Canada Pipe Lines Ltd. is made up of Canadian Delhi Oil Ltd., Western Pipe Lines Group, Canadian Gulf Oil Company, Hudson's Bay Oil and Gas Company Ltd., and Tennessee Gas Transmission Company.



Union Oil of California's planned route for its 225-mile pipe line system from the San Joaquin Valley to the Oleum refinery on San Francisco Bay.

Union Oil of California Plans 225-Mile Crude Line

Union Oil Company of California has announced plans for the company's longest pipe line, a 225-mile line to carry crude oil and unfinished petroleum products from the south central San Joaquin Valley to Union Oil's Oleum refinery on San Francisco Bay. Contracts are expected to be let soon.

Designed for a throughput capacity of 75,000 barrels a day, the line will be of 12-inch pipe from the Junction pump station to a new station to be built near Coalinga. From there, aided by a booster station near Los Banos, the oil will move through a 16-inch line to the refinery. Additional booster stations can increase

WHERE SAFETY IS NO ACCIDENT

The confidence of engineers in FLEXITALLIC Spiral-Wound Gaskets is based on performance. Flexitallic has justified that confidence for more than 40 years by:

—a continual search for new and better gasket materials

—maintaining standards of engineering and design that give complete assurance of a work-proved seal

—making of gaskets on precision winding machines designed by our own engineers.

In nearly every industry, engineers look to Flexitallic for leadership in safety. As the service becomes more hazardous — in aviation, atomic research, power plants, process industries, and aboard ship—the need for Flexitallic Gaskets becomes more urgent.

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Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285".

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*Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue*—it's our exclusive blue-dyed Canadian asbestos filler.

the system's future capacity to 110,000 barrels daily.

When the project is completed in 1957, Union will tie it in with two existing 8-inch lines between Junction and Avila on the coast. One line will continue to carry crude oil from the San Joaquin Valley to Union's Santa Maria refinery. The other line will carry Santa Maria's production of cracking stock and pressure distillate to Junction and the new line will take it from there to Oleum.

Southern California Gas Company

California Companies Receive OK For Topock–Newhall Gas Line

and Southern Counties Gas Company have received approval from the California Utilities Commission to construct the proposed 236-mile 30-inch natural gas transmission line from Topock, Ariz., to Newhall, Calif.

At the same time, approval also was granted for a 49-mile line between Newhall and Alhambra and an additional 19-mile link from Victoria station to Placentia.

Route of the main portion of the line, estimated to cost $26.9 million, extends from Topock westward through desert country and passes through Pisgah, Victorville, Palmdale and on to Newhall. Contracts are expected to be let in August for the major portion of the line from Newhall to Topock, Ariz.

Construction is underway on the Alhambra to Newhall line, expected to be completed by December 1. Alex Robertson Company will build 13 miles from the company's Alhambra station to the westerly end of Glendale; Macco Corporation will work on a 16-mile stretch from Encino to Glendale; and Joe E. Young Pipeline Contractor, Inc., will construct 19 miles from Encino to Newhall.

The Public Utilities Commission order approves the request of the two companies for additional gas up to 328.8 million cubic feet daily, from El Paso Natural Gas Company. The order also specifies that the two companies must arrange with Pacific Gas & Electric Company to inter-connect the Topock-Newhall line and the PG&E—Milpitas line at two points—one in the vicinity of Pisgah and the other at the Colorado river on the California-Arizona border.

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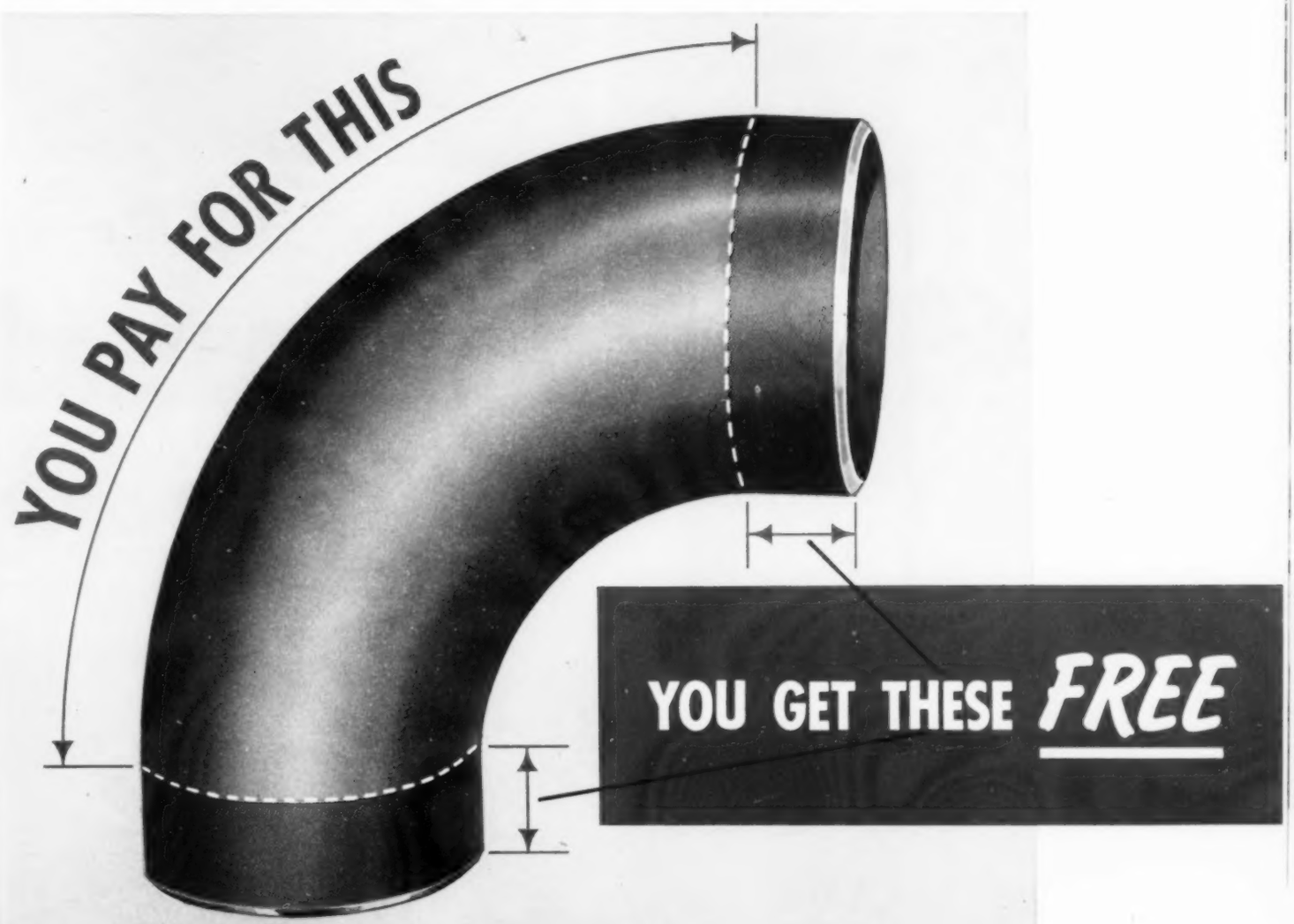
Natural Gas Pipeline Plans New Facilities in Texas

Natural Gas Pipeline Company of America is proposing construction of $3 million in pipe line facilities which include 25 miles of pipe line, 5280-horsepower in field compressor stations and various field lines and metering facilities from the Quinduno field in Roberts County, Texas.

The new facilities would enable Natural Gas Pipeline to take 20 million cubic feet of natural gas daily from the Quinduno field. The proposed 25-mile line would extend from the Quinduno field to a connection with its existing system. Related applications have been filed by four independent producers proposing to sell gas to the pipe line company in the Quinduno field.

MIDWEST "LONG TANGENT" ELBOWS



In no other welding elbow do you get this "bonus" of long tangents. The dotted lines show where standard elbows end. Each shaded straight end equals ¼ of the nominal fitting diameter . . . a 12″ Midwest "Long Tangent" Elbow has tangents 3″ long. As a result of the advantages listed at the right, substantial savings are made on many piping systems by using Midwest "Long Tangent" Elbows . . . which cost no more than other elbows. For further information, write for Catalog 54.

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Plants: St. Louis, Clifton, N. J. and Los Angeles

Sales Offices:
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ADVANTAGES OF MIDWEST "LONG TANGENT" ELBOWS

- ★ They save pipe.
- ★ They often eliminate short nipples and their extra welds.
- ★ They save time and money in lining up and clamping pipe and fitting.
- ★ They make it easier to apply slip-on flanges.
- ★ They remove the circumferential weld from point of maximum stress and can be sleeved.
- ★ THEY COST NO MORE THAN OTHER ELBOWS

MIDWEST HAS THE MOST COMPLETE LINE

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MIDWEST **WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS**

ALL OVER THE SPREAD . . .

Bonus-Powered In

helps new "6

Low, wet, river delta terrain in some spots of the 86-mile contract, stymies the self-propelled trencher. So, an International diesel-powered Bucyrus-Erie 22-B back-hoe "floats" on a timber skid to continue cutting.

A minor trench cave-in, but a Bucyrus-Erie 22-B clamshell powered by an International UD-14 Diesel Engine, speedily opens and cleans up the trench. Total of seven International engines help keep the schedule clicking.

One of the five International TD-18 tractors on the spread tows a load of four heavy welders through the wet, soft delta land. With 24,300-lb. pull in first gear, a new TD-18 has sure-going tow-power to spare!

International® Equipment

"big-incher" push 1.4 miles daily!

The International Superior TD-24 torque-converter rig is *there*—with fifty-five-ton lift capacity—200 net engine hp, and exclusive Planet Power steering! It can spear-head handling big spans of "30-incher" wherever top capacity and precise control count.

Fifteen other International diesel units are there, too, on this Houston Contracting Company spread—with exclusive, seconds-fast gasoline conversion starting and other time-saving International features—to help average 1.4 miles daily across tough delta terrain on America Louisiana's new big-incher to Detroit. Why not "press the button"—prove to yourself that new bonus-powered International Superior pipe-boom tractors beat anything else on tracks for capacity and dependability!

110,000-lb. capacity International Superior TD-24 Pipe-Boom outfit moves down the line—cradling a heavy span of 30-inch pipe. It also carries the International diesel-powered cleaning and priming unit. This torque-converter tractor carries maximum hydraulically - actuated counterweights. Planetary steering with power to both tracks makes turning with these heavy loads fast and easy.

International diesel TD-14 (one of four on the job) uses bucket-backfiller to make short work of covering the pipe. Concrete clamps, normally used in river crossings, are employed to help hold down the pipe in bog spots.

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A COMPLETE POWER PACKAGE INCLUDING: Crawler, Wheel, and Pipe-Boom Tractors . . . Self-Propelled Scrapers and Bottom-Dumps . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Trucks . . . Diesel and Carbureted Engines . . . Motor Trucks

TGT Construction Underway On 216-Mile Addition to System

Work has started on a 216-mile addition to the Tennessee Gas Transmission Company's pipe line system in Ohio and Kentucky and completion is expected by early fall.

Part of the company's $56 million expansion program, the project involves laying 30-inch and 26-inch pipe parallel to existing TGT pipe lines. Bechtel Corporation has the contract for laying 74 miles of 30-inch line from Danville to Cave City, Ky. H. C. Price Company will construct an 81-mile stretch of 26-inch line north of the Ohio river to near McConnelsville, Ohio. The remaining 61 miles of 26-inch is under contract to Oklahoma Construction Company.

The company's current expansion program includes construction of new compressor stations near Winnsboro, La., and New Albany, Miss.; horsepower additions to existing compressor stations near Isola, Miss., and Campbellsville, Winchester and Catlettsburg, Ky.; and a 355-mile extension of the company's natural gas gathering system into southeast Louisiana.

Less Breakage at Low Temperatures
COSTS LESS ON THE PIPE
Less Breakage Near Roll Core
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Normal Curves At Straight-line Tension

PERRAULT 15 lb. FELT Glass Fibre Reinforced

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Glass, Asbestos and Kraft Wrap . . . Rock Shield . . . Coating & Wrapping, Cleaning & Priming Machines . . . Tar Kettles, Patch Pots, Burners & Accessories . . . Pneumatic Inside Line-up Clamp . . . Pneumatic-tired Lowering-in Cradle . . . Pipe Cradles . . . Tongs, Sling Belts, Hooks, Clamps, Hand Tools, Supplies and Equipment of Every Sort.

Perrault fifteen-pound asbestos pipe wrap is reinforced with longitudinal glass fiber strands at one-fourth inch spacing. It costs no more delivered to the job, but by eliminating most shut-downs due to breakage, it costs far less on the pipe. Since it is not brittle when cold. Perrault reinforced felt is especially recommended for Fall and Spring Projects where material will be kept in unheated storage. Let us show you a sample and quote your next job. We also offer the best in other pipe wraps: Owens-Corning Glass, Kerr-McGee Outer Wrap, Kraft, and the original Rock Shield.

PERRAULT EQUIPMENT COMPANY

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Pacific Gas and Electric's 85-Mile Addition Underway

Construction is underway on 85 miles of parallel sections to Pacific Gas and Electric Company's "Super Inch" natural gas line. Estimated to cost $10 million, the project is contracted to Midwestern-Johnson-Dixon.

Three sections of 34-inch steel pipe will be installed paralleling portions of the 502-mile main line extending from the California-Arizona border near Topock, Ariz., to the Milpitas metering station near San Francisco Bay. Work will be completed this year.

Normal capacity of the main line, which delivers gas from Texas and New Mexico wells, will be increased from 700 million to 750 million cubic feet daily.

Construction begins in the Santa Clara County hills near Gilroy, Calif., on a 38.5-mile section extending northward to Milpitas. The second section of 25 miles is from Panoche Junction to Llanada, Calif. and the final section will be built from Topock to a point 21.5 miles westerly.

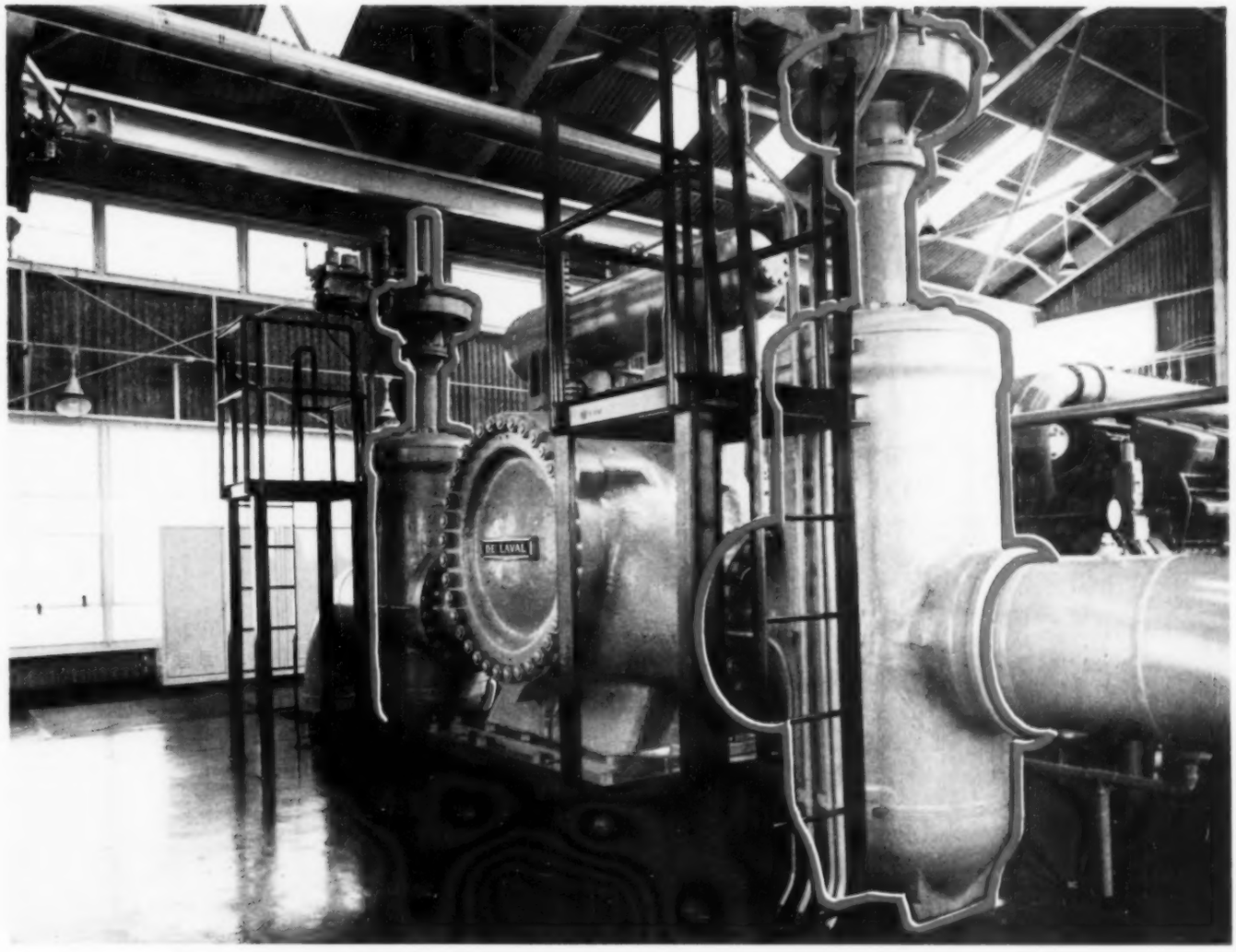
The project includes, under other contracts, the installation of 6620-horsepower of additional compressor capacity. Eight 1760-hp compressors at Kettleman Compressor Station will be increased to 2050-hp. At Topock, an existing 2500-hp compressor will be converted to 3300-hp and a new 3500-hp machine will be installed.

Construction contract will be awarded later for a second pipe line bridge to be built across the Colorado river at Topock carrying a new line to be connected to the El Paso Natural Gas Company system.

Gulf Interstate to Build $2 Million Station Facilities

Gulf Interstate Gas Company has received Federal Power Commission authorization to construct and operate natural gas pipe line facilities estimated to cost $2 million.

The proposed construction consists of addition of one 2000-horsepower compressor unit at each of the company's compressor stations at Clementsville, Ky., Hampshire, Tenn.; Banner, Miss., and Delhi, La. The additional horsepower will increase each station's rating to 10,000 horsepower.



W-K-M VALVES *of course*

In Transco's new centrifugal compressor station

There's no change in the shape of the stream—no loss of pressure as gas flows through the W-K-M Valves on either side of the Centrifugal Compressor in Transco's pioneer station of this type. Opening through the valve is the same I.D. as the pipe — the bore is smooth. There are no restrictions — no projections to set up turbulence, to cause pressure drop. The parallel expanding gate of the W-K-M Valve provides a positive shut-off.

For maximum performance with minimum maintenance on pipelines anywhere, any size, it's always wise to specify W-K-M through-conduit, parallel expanding gate valves. Ask your W-K-M representative or write for new Pipeline Valve Catalog 300.

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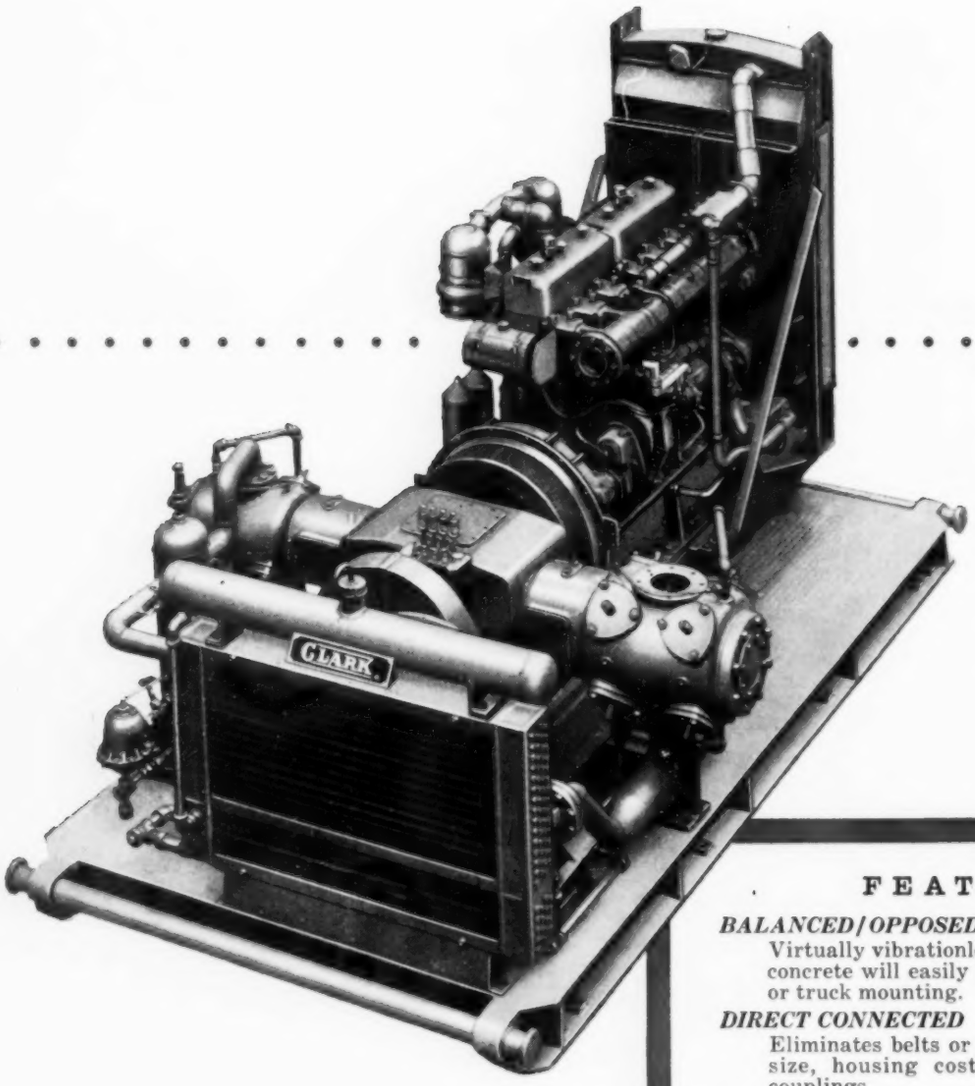

FEATURES

BALANCED/OPPOSED COMPRESSOR DESIGN
Virtually vibrationless . . . a couple of yards of concrete will easily level it. Perfect for barge or truck mounting.

DIRECT CONNECTED
Eliminates belts or gear drives. Reduces skid size, housing costs. Simple rubber block couplings.

ONE PIECE SKID
Simple to install, move or shelter . . . only 7' 3" x 15', rigid heavy "I" beam construction.

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For maximum efficiency and thru-put.

CONSERVATIVE PISTON SPEED
Lower than on most Clark stationary compressors, assures long cylinder life.

HEAVY DUTY RADIATOR
Straight finned tubes. Easy to inspect or clean, inside or out. Provides intercooling and cylinder jacket cooling.

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No field assembly. Shipped as a complete unit.

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Five makes of proved engine designs available.

APPLICATIONS
Use it for gas lifting, gas gathering, gas boosting, pipeline testing, recycle plant feeders, other field services.

Packaged Compressor

CFA now on tour
—in Oklahoma, Kansas, Colorado, Texas and Louisiana.
Watch your newspaper for date and location of demonstration.

Designed by Clark for gas lifting or gathering

You asked for this field compressor—as rugged, compact and perfectly balanced as the famed "Midget Angle" but of half the horsepower.

Now you have it, in the new Clark Model CFA. Rated at 75-200 bhp, this packaged compressor station is ideal for gas lifting or gas gathering of from one to a dozen wells. This is particularly true when well spacing is wide and multiple sands are being worked.

The CFA uses a new specially designed 5" stroke balanced/opposed compressor directly connected to a standard design gas engine. The compressor and engine, together with a heavy duty radiator, scrubber, etc., are mounted on a rugged steel skid.

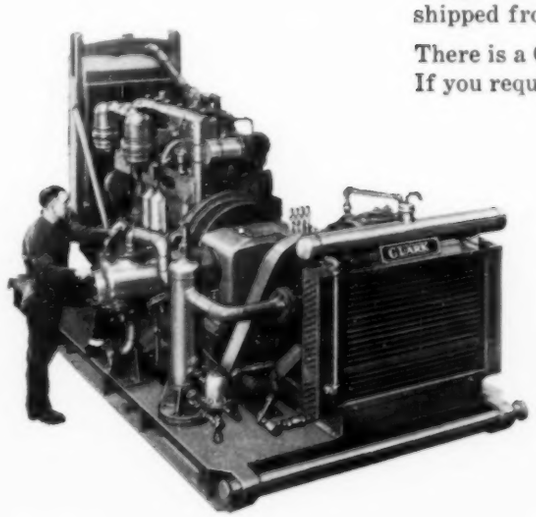
The CFA is virtually vibrationless in operation because of its balanced/opposed action. In most cases the small amount of concrete used to level the unit will provide ample support.

Operating at engine speed eliminates the need for cumbersome belt and gear drives. The resulting compactness permits mounting the complete unit on a skid measuring only 7′ 3″ x 15′.

Easily and speedily transported on an average size truck, this new field compressor can also be operated on truck or floating barge. The compact design minimizes costs if a shelter is required.

You have no field assembly problems. The CFA is factory assembled, tested and shipped as a complete unit. Because of standardization the CFA can be shipped from stock in most instances.

There is a Clark CFA specialist in your area to give you all the facts. If you require greater horsepower, ask him about the Clark HMA and HMAB.



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Packaged Compressors

For more data on advertised products, use Readers' Service Cards, last page.

Mountain Fuel to Buy Gas From Pacific Northwest

Mountain Fuel Supply Company has entered into a service agreement with Pacific Northwest Pipeline Corporation to purchase 50 million cubic feet of gas daily from Pacific Northwest and transport the gas to customers in western Wyoming and Utah this fall.

Mountain Fuel will file an application soon with the Federal Power Commission for authorization to build 38 miles of 20-inch parallel line and install 2640 horsepower of gas compressors to transport the increased gas supply. Mountain Fuel will buy the gas where the Pacific Northwest line crosses Mountain Fuel's line in Sweetwater County, southern Wyoming.

The additional supply will bring the company's capacity to 306 million cubic feet daily. The daily gas volume required to supply the company's peak demand has increased during the past ten years from 89 million cubic feet a day to 250 million cubic feet at present.

Washington Gas Light Plans 28-Mile Line in Virginia

Washington Gas Light Company has applied to the Federal Power Commission for authority to build 28.8 miles of pipe line in Virginia at an estimated cost of $3.4 million.

The proposed facilities include 26 miles of 24-inch line from the metering station of Atlantic Seaboard Corporation near Dranesville, Va., to near Washington where 2.7 miles of 20-inch will connect it with a line leading to District of Columbia facilities. Additional gas would be supplied for the Virginia area by the new facilities.

Northern Natural Receives Temporary O.K. for 2 Projects

Northern Natural Gas Company has received temporary authority from the Federal Power Commmission to construct gas pipe line facilities to increase sales capacity and to test its Redfield, Iowa., storage project.

Northern will build 15.5 miles of loop line in Nebraska and install an additional 12,640-horsepower in compressor capacity on its system in Texas, Kansas, Nebraska and Iowa at an estimated cost of $4.7 million. The FPC also approved temporarily the construction and operation of 28.4 miles of line and modification of compressor units in the company's Redfield storage project on an experimental basis to permit testing operations. Estimated cost of the storage project is $1.5 million.

The facilities covered by the temporary authorization are part of an over-all $32 million project designed to increase the company's system sales capacity by about 90 million cubic feet of gas daily.

NATO Projects in Italy Open for U. S. Bids

Two new projects in Italy have been opened to U. S. bidders under the international competitive bidding procedure of the North Atlantic Treaty Organization.

One project is for the construction and installation of four motor-driven fuel oil pumping units at Gaeta and the second is for repair of three metal tanks and construction and installation of one new tank.

Potential bidders must submit their applications to Ministero Difesa-Marina, Direzione Generale Genio Militare per la Marina, Divisione Amministrative, Rome.

Applications must be accompanied by the completed questionnaire concerning the firm's capabilities. These questionnaires are available from Trade Development Division, Bureau of Foreign Commerce, U. S. Department of Commerce, Washington 25, D. C.

Proposed Pipe Line Construction

COMPANY	Length in Miles	Diameter	Type	Origin and Terminus	Estimated Cost	Status
Alberta Gas Trunk Line, Ltd.	547	6-34	Gas	From Alberta fields to western terminus of Trans Canada Pipe Line, Ltd.	$47 million	Approved
American Gilsonite Company	71	6	Gilsonite Slurry	From Bonanza, Utah, to Gilsonite, Colo.	$2 million	Approved
American Louisiana Pipe Line Company	117	....	Gas	Payne, Ohio to Bridgman, Mich.	$7.8 million	Authorized
Andes Pipeline Corp.	500	12	Gas	From Villamontes, Bolivia, across Andes to Antofagasta, Chile	$30 million	Planned
Atlantic Seaboard Corporation	86	20, 26	Gas	In West Va. and Va. paralleling sections of the company's existing line and extending from Seabcard's Lost River compressor station to its Bickers compressor station interconnecting the company's lines.	$8.5 million	Contract let
Bolivian Gulf Oil Co.	201	....	Crude	Sicasica, Bolivia to Arica, Chile	.....	Planned
Chaco Pipeline & Refinery Corp.	450	....	Products	From Glenn McCarthy's Bolivian wells to new refinery at Conception, Paraguay	.....	Planned
Coastal Transmission Corp.—Houston, Texas	565	20-26	Gas	McAllen, Texas—Louisiana connection, Houston, Texas Gas, plus 272 miles of laterals	$68 million	Before FPC
Colorado Interstate Gas Co.	800	16-30	Gas	Laramie, Wyo. to Beatrice, Neb. to deliver gas from Rocky Mountain area and Texas and Oklahoma Panhandle fields to Natural Gas Pipe Line Co. of America	$76 million	Before FPC
Compania Shell de Venezuela	177	20	Gas	La Paz field to Cardon refinery on Paraguana peninsula	$20 million	Planned
Consolidated Gathering Systems, Ltd.	198	....	Crude	Sturgeon Field—Edmonton	.....	Planned
Creole Petroleum Corp.	16	34	Crude	Pachaquero to Lagunillas, Venezuela	$2 million	Planned
	94	28	Crude	Temblador to Caripito, Venezuela	$5.6 million	Planned
Deep Rock Gas Co.	120	6	LPG	Tioga, N.D.—Canadian border	.....	Planned
El Paso Natural Gas Products Co.	240	8	Products	Midkiff natural gasoline plant in Permian Basin to El Paso	.....	Planned
Gulf Oil Corp.—Pittsburgh, Penn.	33	8	Crude	Citronelle, Ala. field to Mobile	.....	Planned
Houston Texas Gas & Oil Co.—4604 Main St., Houston	961	12-30	Gas	Baton Rouge, La. to Miami, Fla. plus 496 miles of laterals and compressor facilities	$105 million	Before FPC
Hydro-Carbons Pipe Line, Ltd.	800	....	LPG	Edmonton to Winnipeg with gathering system and storage	$35 million	Planned
Inland Natural Gas Co.	320	6-12	Gas	To tap Westcoast Transmission's trunk line at Savona, British Colombia.	.....	Planned
Interprovincial Pipe Line Co.	150	20	Crude	Sarnia, Ont. to Toronto, Ont.	.....	Planned
Interstate Oil Pipe Line Co.	55	8	Crude	Billings, Mont. to Wolf Springs, Mont.	.....	Considered
Iraq Petroleum Co.	50	24	Crude	Homs, Syria, to Mediterranean	.....	Considered
Iron Ranges Natural Gas Co.	115	....	Gas	From Itasca and St. Louis Counties along route of Mesabi range from Grand Rapids to Aurora, Minn.	$5 million	Before FPC
Iroquois Gas Corp.—Buffalo, N.Y.	36	....	Gas	Facilities in Chautauqua, Cattaraugus and Erie counties, N.Y. to develop new underground storage area for natural gas	$2.5 million	Authorized

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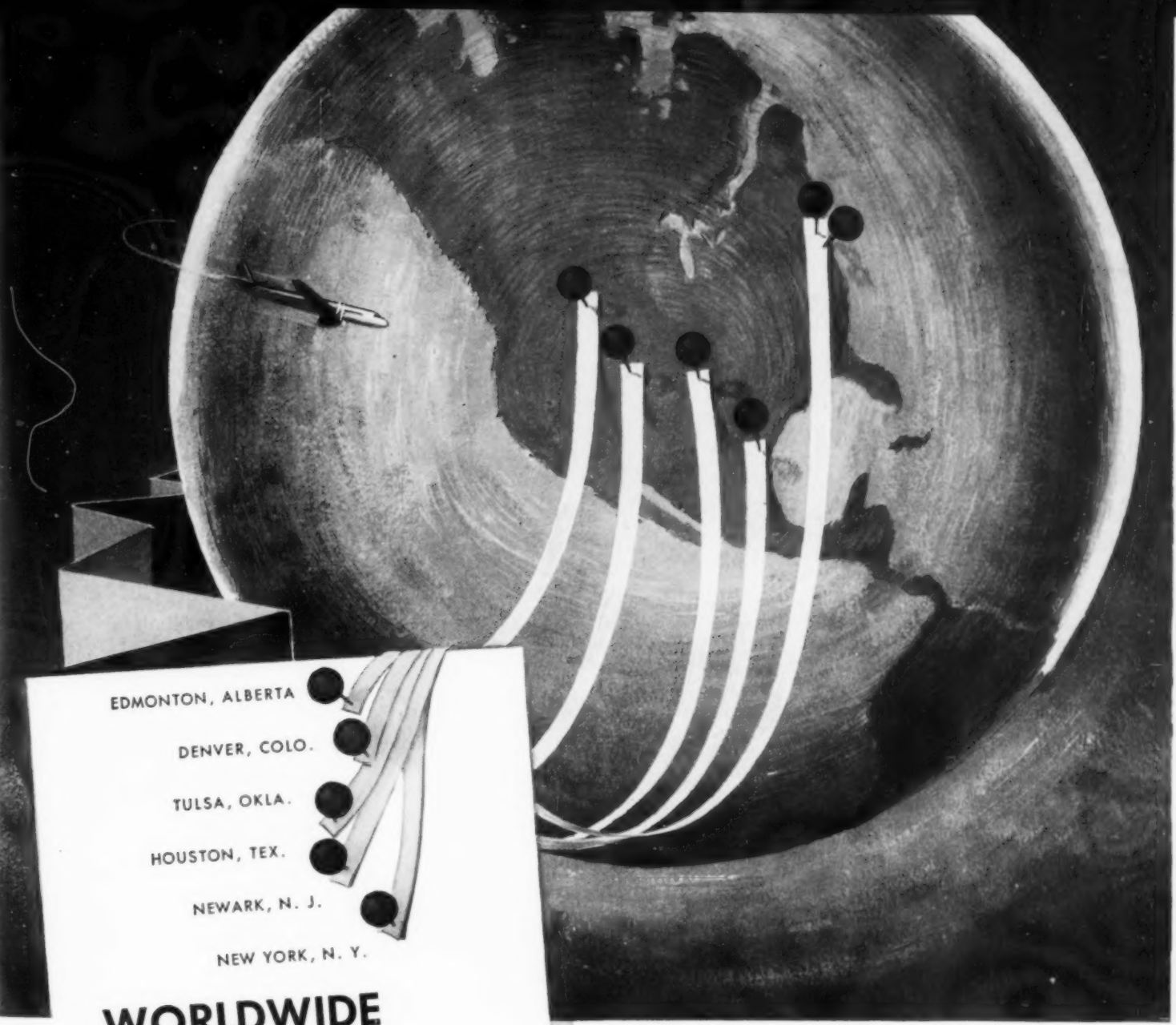

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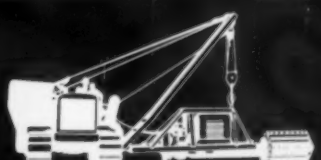

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CLEANING & PRIMING MACHINES

Proposed Pipe Line Construction—(Continued)

COMPANY	Length in Miles	Diameter	Type	Origin and Terminus	Estimated Cost	Status
Kansas-Nebraska Natural Gas Co.	32	....	Gas	Facilities in Nebraska	$4 million	Before FPC
Magna Pipeline Company	40	....	Gas	Underwater line from Anacortes, Wash. to Victoria, B.C.	$6 million	Planned
Michigan-Wisconsin Pipe Line Co.—500 Griswold, Detroit	472	4–24	Gas	Main line loops and extensions in Wisconsin, Illinois and Michigan	$17.6 million	252 miles authorized 95 miles let
Midwestern Gas Transmission Co., Houston, Texas	1112	....	Gas	Emerson, Manitoba—Nashville, Tenn.	$98 million	Before FPC
Montana-Dakota Utilities Co—Minneapolis	44	....	Gas	Various locations in S.D. and Wyoming	$1.4 million	Authorized
	41.8	12	Gas	Williams County, N.D.	$1.4 million	Authorized
Mountain Fuel Supply Company	38	20	Gas	Parallel line and facilities to transport gas from Pacific Northwest line in Sweetwater County, Wyo.	.....	Planned
NATO	1920	4–10	Products	To serve military bases in Western Europe	.....	Foster-Wheeler Prime Contractors, 1330 miles let
Natural Gas Pipe Line Co. of America—20 N. Wacker Dr., Chicago	350	20, 26	Gas	Wise County, Texas—Fritch, Texas	$28.5 million	Authorized
	25	....	Gas	Quinduno field in Roberts County, Texas	$3.2 million	Before FPC
	480	30, 36	Gas	Loops at various points along existing line	$80 million	Before FPC
New York State Natural Gas Corp.	27	....	Gas	Elk County, Penn. to Luthersburg gas field in Clearfield, Jefferson and Indiana Counties, Penn.	$1.5 million	Authorized
North Carolina Natural Gas Corp.	575	3–16	Gas	Mooresville eastwardly across North Carolina	$13 million	Authorized
Northern Natural Gas Co.—2223 Dodge St., Omaha	167	24	Gas	Farmington, Minn. to Duluth, Minn. and Superior, Wis.	$12 million	Before FPC
	....	....	Gas	To interconnect with Natural Gas Pipe Line	$244,000	Planned
	28.4	30	Gas	Test lines to underground storage near Redfield, Iowa	$4.8 million	Authorized
	15	....	Gas	Loop line in Nebraska and install additional compressor horsepower in system in Texas, Kansas, Nebraska, Iowa	$4.7 million	Authorized
Offshore Gathering Corp., Houston	364	24, 26, 30	Gas, Crude	Texas side of Sabine River 25 miles offshore La. to Mississippi side of Pearl River	$150 million	Before FPC
Pacific Gas & Electric Co.	150	34	Gas	Various loops, between Topock, Ariz.—Milpitas, Calif.	$20 million	85 miles let
	83	12, 18, 20	Gas	Glenn County areas to Sacramento region	$5 million	Planned
Pacific Northwest Pipe Line Corp.—Salt Lake City, Utah	1,487	22, 26	Gas	San Juan Basin—Pacific Northwestern states and Canadian border terminus near Sumas, Wash. plus 732 miles of supply and sales laterals	$246 million	Contracts let for main line and 477 miles of laterals
	50	46	Gas	To serve industrial customers at Uravan and Nucla, Colo.	$1 million	Authorized
Pembina Pipe Line, Ltd.	100	....	Crude	Gathering line and new pumping unit in West-Central Alberta	$4.5 million	Planned
Pennsylvania Gas Co.	38	8, 10	Gas	In Erie and Warren Counties, Penn., and Chautauqua County, N.Y.	$930,000	Before FPC
Petroargentina	370	16	Crude	Newguen—Bahia Blanca, Argentina	$40 million	Planned
Petroleos Mexicanos—Ave. Juarez, 94, Mexico City	440	20	Gas	Brazil—Tampico—Poza Rica, Mexico	.....	Planned
	145	12	Crude	18 de Marzo Field—Monterrey, Mexico	.....	Considered
	80	8	Products	Guaymas—Los Mochis	$1 million	Planned
Phillips Petroleum Co.—Bartlesville	54	6	Products	Goldsmith—Borger, Texas	.....	Planned
	22	20	Gas	Roberts County, Texas, to Rock Creek gasoline plant	.....	Approved
Piedmont Gas Co.—Hickory, N.C.	78	2–8	Gas	From connection with Transcontinental Gas Pipe Line to serve customers in North Carolina	$2.6 million	Before FPC
Saskatchewan Power Corp.	80	....	Gas	Hatton gas field to Success, Sask.	.....	Planned
	40	....	Gas	Moose Jaw, Sask. to Regina, Sask.	.....	Planned
Sinclair Oil & Refining Co. and Socony Mobil Oil Co.	211	....	Crude	San Silvestre field, Barinas, Venezuela, to Puerto Cabello on Caribbean sea coast	$25 million	Planned
South Alberta Pipe Line, Ltd.	46	10	Gas	Etzikom Field—Medicine Hat, Alberta	$1 million	Planned
South Saskatchewan Pipe Line Company	58	12	Crude	Cantuar field to Dollard field, Saskatchewan	$3 million	Planned
Southern Calif. Gas Co. & Southern Counties Gas Co.	236	30	Gas	Topock, Ariz. to Newhall, Calif.	$26.9 million	Approved
	49	....	Gas	Newhall to Alhambra, Calif	$6.6 million	Contract let
Southern Natural Gas Company	52	....	Gas	Various locations in Ga. and La.	$2.2 million	Authorized
Southern Pacific Pipe Lines, Inc.	300	....	Products	From San Francisco Bay area to Reno—Fallon, Nev. area	$16 million	Planned
Stanmount Pipe Line Co.	140	10	Crude	Cayiga and Beaver Lake Fields, N.D. to connect with Interprovincial Pipe Line	.....	Planned
Sturgeon Pipe Line Ltd.	100	12	.....	Sturgeon Lake Field—Trans-Mountain system	$6,500,000	Planned
Sui Gas Transmission Company	200	16	Gas	Sui field in Pakistan to Multan in southern Punjab	.....	Planned
Sunflower Pipe Line Co.—Tulsa, Okla.	265	3–6	LPG	Kearny, Grant and Haskel Counties, Kansas—Wichita, Kansas	$3.5 million	Authorized
Tecumseh Pipeline Co.	....	20	Crude	To connect to principal crude line carriers in Chicago area for movement to east	.....	Planned
Tennessee Gas Transmission Co.—Box 2511, Houston (See also Midwestern Gas Transmission Co.)	100	....	Gas	Gathering lines in Texas and Louisiana plus station additions	$18.6 million	Before FPC
	162	....	Gas	Loop Lines in Kentucky, Ohio, and Pennsylvania	$24.3 million	Before FPC
Texas Eastern Transmission Corp.	422	30	Gas	McAllen to Vidor, Texas	Estimated	Before FPC
	530	30	Gas	Loops at various points between Kosciusko, Miss. and Uniontown, Penn.	Cost of Entire Project	Before FPC
	45	24	Gas	Provident City, Texas crossover to McAllen-Vidor line	$150	Before FPC
	135			Supply and delivery lines laterals	Million	Before FPC
Texas Eastern Transmission Corp. and Texas Eastern Penn-Jersey Corp.	....	....	Gas	Additional compressor facilities to system in Penn.	$8.3 million	Before FPC
Texas Gas Transmission Corp	198	20	Gas	East Lake Palourde Gas field, La. to Eunice, La. and loops paralleling existing system in Arkansas, Mississippi, Tennessee, Kentucky, Indiana	$20 million	Authorized
	40	6–30	Gas	Parallel lines and compressor additions on existing lines in Louisiana, Missouri, Mississippi, Illinois, Kentucky	$6 million	Before FPC
Trans-Canada Pipe Line, Ltd.—Calgary, Alberta	2250	30, 36	Gas	Alberta—Eastern Canada	$378 million	Contracts let for 4 spreads
Trans Carolina Pipeline Co.	280	8–18	Gas	Transmission line and compressor facilities plus 567 miles of laterals in tidewater areas of North and South Carolina	$21.6 million	Before FPC
Transcontinental Gas Pipe Line Corp.—3100 Travis St., Houston	....	....	Gas	Connecting facilities with Texas Eastern Penn-Jersey in Pennsylvania and New Jersey	$131,628	Authorized
	24.2	....	Gas	Gathering Lines from South Bayou Mallet, Maxie and Happytown Fields, La.	$754,000	Authorized
	12	....	Gas	Live Oak gas field, Vermillion Parish, La. plus two meter stations	$707,000	Before FPC
	277	30, 36	Gas	In Louisiana, Mississippi, Alabama, Georgia, S. Carolina, N. Carolina, Virginia, Maryland, Pennsylvania	$42 million	Before FPC
Trans-Europe Pipe Line	900	....	Crude	North Sea at Wilhelmshaven, Germany, to Marsailles, France. Offshots from laterals will serve Switzerland, Luxemborg and Holland.	$152 million	Considered
Union Oil Co. of Calif.—Los Angeles, Calif.	225	12, 16	Crude & Products	San Joaquin Valley to Union Oil's Oleum refinery on San Francisco Bay.	.....	Planned
United Natural Gas Co.	50	12	Gas	Elk County—Jefferson County, Pa.	.....	Planned
U. S. Navy	450	8	Gas	Gubik Field—Fairbanks, Alaska	$20 million	Planned
Washington Gas Light Co.—Washington, D.C.	28	20, 24	Gas	From metering station of Atlantic Seaboard Corp. to Washington to connect with line leading to District of Columbia facilities	$3.4 million	Before FPC
Westcoast Transmission Company, Ltd.	270	8–26	Gas	Various locations in Peace River region	.....	Planned
Wilcox Trend Gathering System, Inc.	16	16	Gas	Gathering lines to Provident City, Texas	$2.9 million	Before FPC
Winnipeg and Central Gas Co.	450	4–8	LPG	Tioga, N.D.—Winnipeg, Canada	$20 million	Planned
YPF	808	....	Gas	Campo Duran, to Buenas Aires, Argentina	$76 million	Planned
	635	....	Crude	Campo Duran to San Lorenzo, Argentina	$24 million	Planned
	621	....	Crude	Mendoza to San Lorenzo, Argentina	$19 million	Planned

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Rockwell-Nordstrom valves close with just a quarter-turn. Pressurized lubricant makes operation smooth, easy . . . jacks the plug for *instant* operation.

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Rockwell-Nordstrom valves have *no bonnet or body cavities* to collect valve jamming sediment. Flow is clean as a whistle . . . minimum pressure drop.

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Rockwell-Nordstrom valves have *no exposed seats* to wear out . . . lubricant reduces wear for longer life at lower cost.

Versatility?

Rockwell-Nordstrom valves are available in sizes to 30", API ratings to 10,000 lb. They can be ordered with wrench, gear or power operators to fit any need.

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Rockwell-Nordstrom valves cost no more to buy than ordinary valves. And they *stay* reliably on stream at *lower* cost than *any* other valve.

You get all the performance and economy you look for in pipeline valves when you specify "Rockwell-Nordstrom." Get the complete story from your nearby supplier, or write Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

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How to do it

PIPE LINE HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1, Texas

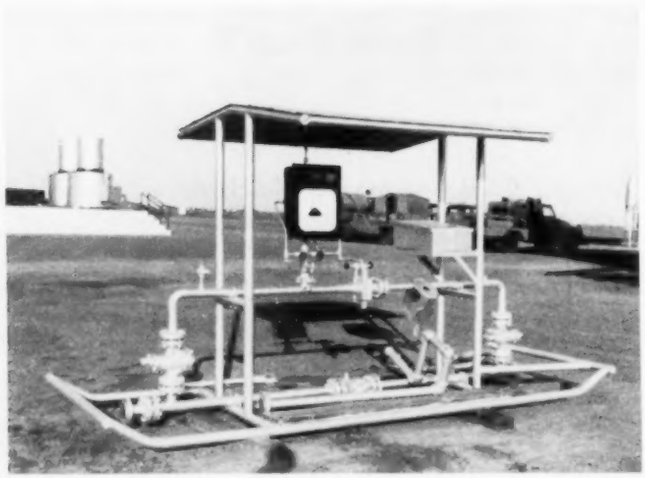
Make Welders' Canopy From Rods and Canvas

Here is a good shade for welders making a tie-in on a Mississippi river crossing. To make the canopy, three one-inch rods were bent in a U-shape and cross rods tack-welded at the bottom as shown. A couple of two by two's were lashed to the end members with small line. Welders and the device move quickly along the line during tie-ins and have shade, shelter and ventilation. It can be made quickly and four men can easily carry it from joint to joint.

Rack Keeps Equipment Handy for Repair Crew

Line-up clamps, small tools, cans of grease, pipe dope, etc., can be stowed on a handy rack similar to this one fabricated at a South Texas compressor station. A boat used occasionally for pipe line work also is stowed over maintenance tools.

The rack can be made from scrap pipe material welded and set into the ground. Plate steel shelves provide storage space for small tools and grease cans and the rack arrangement stows larger equipment. Short sections of pipe are welded to the side of the rack to hold line-up clamps as shown.



Mobile Metering Station Facilitates Field Sales

The skid-mounted metering station shown is used where pipe line sales are made to drilling contractors and other field installations on a temporary basis. The unit can be moved to location by truck and set up quickly in the field.

The orifice meter run, skid frame and shelter are made up of two-inch pipe. A galvanized roof protects the metering installation and the recorder from weather. A steel box is also provided for fittings, charts, etc.

All piping and meter fittings have been made up and calibrated beforehand and can be moved to location and tied in to an existing system to provide a quick sheltered field metering station that insures accurate measurement.

Welding Truck Is Equipped With All Needs for Job

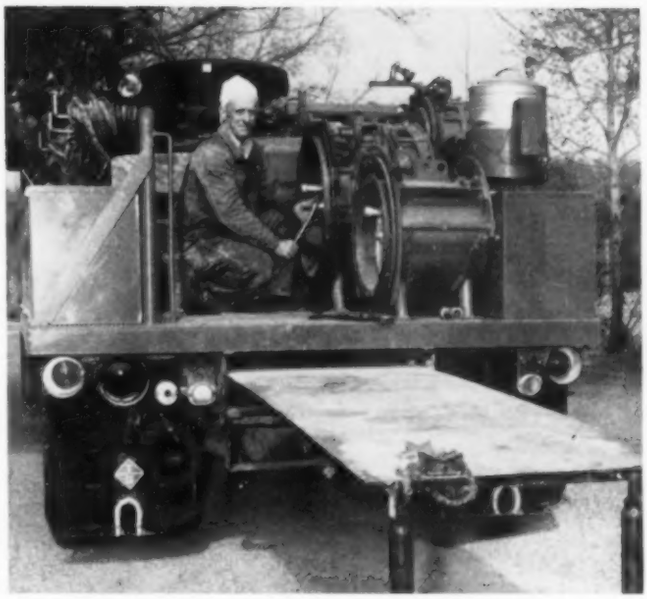
Charlie Cotten is one district welder who has built into his truck just about everything he will ever need on a pipe line job.

Shown in the foreground is a work table which slides under the truck bed when not in use. The table top is a one-quarter-inch steel plate supported by two adjustable legs of two-inch pipe. One-inch hex nuts are welded to the top of each leg and others are welded to the bottom of the table top at the leg positions. A one inch stud fits into these nuts and takes care of adjustments that may be needed on rough terrain. The legs are removed and the table retracted into the truck bed when not in use.

Tool boxes are mounted on both sides of the truck. These have sliding drawers and are large enough to hold all the small tools that may be required on a job.

A rack for a water can and cup dispenser is a permanent fixture above the right hand tool box.

Racks for 18 and 26-inch beveling machines are attached to the truck bed and a 12-inch beveling machine rack is attached above the right hand tool box forward of the water can.



A recess is provided forward of the left hand tool box for holding oxygen and acetylene cylinders. Two-inch pipe is used to make up ground cable and lead cable racks attached to the truck bed on left side.

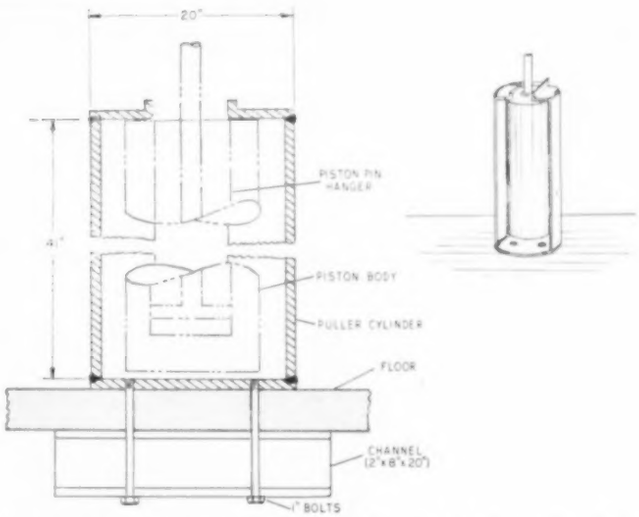
Cylinder Facilitates Piston Rod Pulling

This piston pin hanger puller saves compressor station maintenance men time and represents a safer way of doing the job.

The puller is constructed of a piece of pipe, 20 inches in diameter and 41 inches long. A 20-inch blind flange is welded to the bottom of the pipe. Two pieces of angle iron, both 12-inches long and welded to the two top sides of the pipe, hold the piston body while the rod and pin hanger are removed. One side of the pipe is cut out to permit access for the piston as shown.

To use it, the power piston assembly is placed in the "chamber" of the device through the cut-out side. A crane then pulls the rod and hanger from the piston body, while the two angle irons hold the piston body in the chamber.

Two anchor bolts through the blind flange tie the pulling holder to the floor. Steel channels below the floor provide reinforcement.

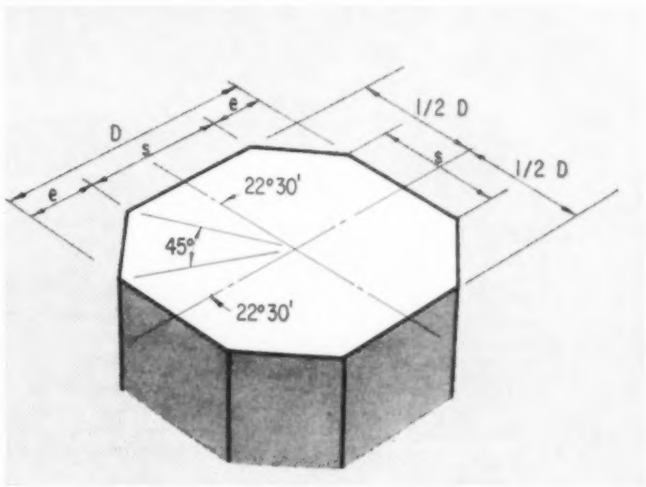


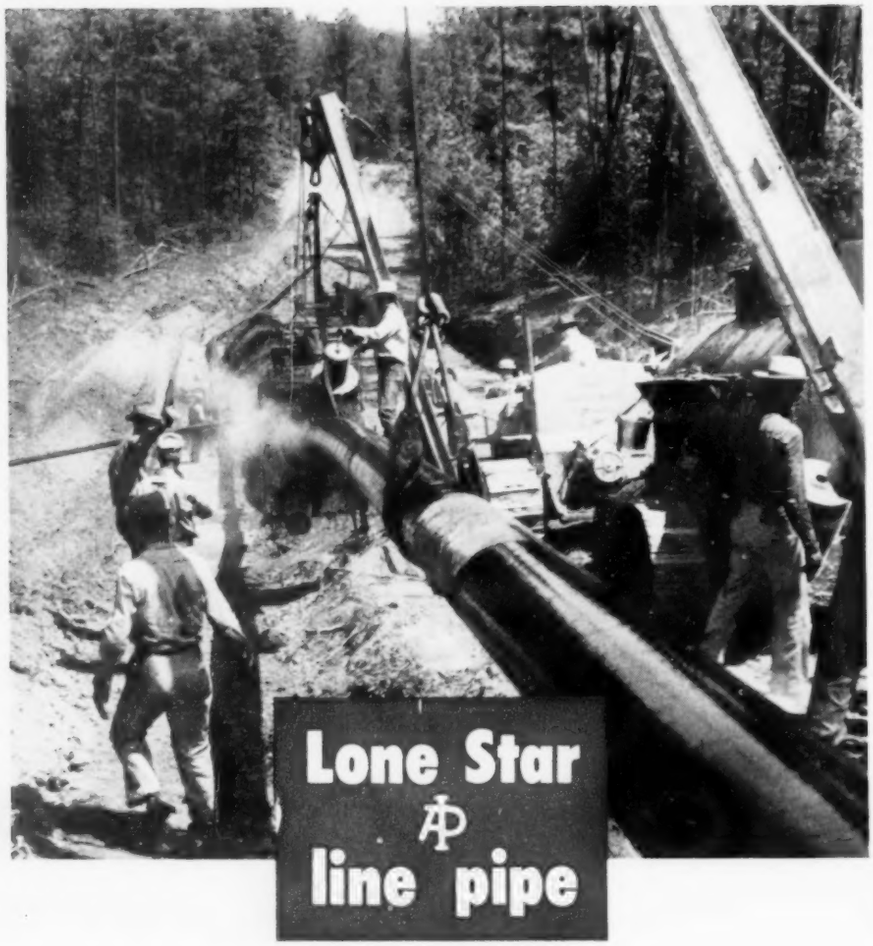
Layout Slab Forms Quickly Using Short Cut Equation

If a well-designed concrete foundation for scrubbers or other vertical vessels is your problem, this idea may help you. One gas pipeliner uses it when constructing bases for new equipment.

Vessels of varying sizes and weights require slabs of different sizes. To design the wooden forms, use the diagram as follows.

Select the over-all width "D" required. The length of each of the eight sides "s" can be found by multiplying "D" by .414. The offset "e" is found by subtracting the side "s" from "D" and dividing by 2.





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HINTS . . .

Locate Test Leads In Accessible Box

To make cathodic protection test leads easy to locate and accessible, one pipe line company uses a piece of electrical conduit and a terminal box clamped to a pogo stick type fence crossing.

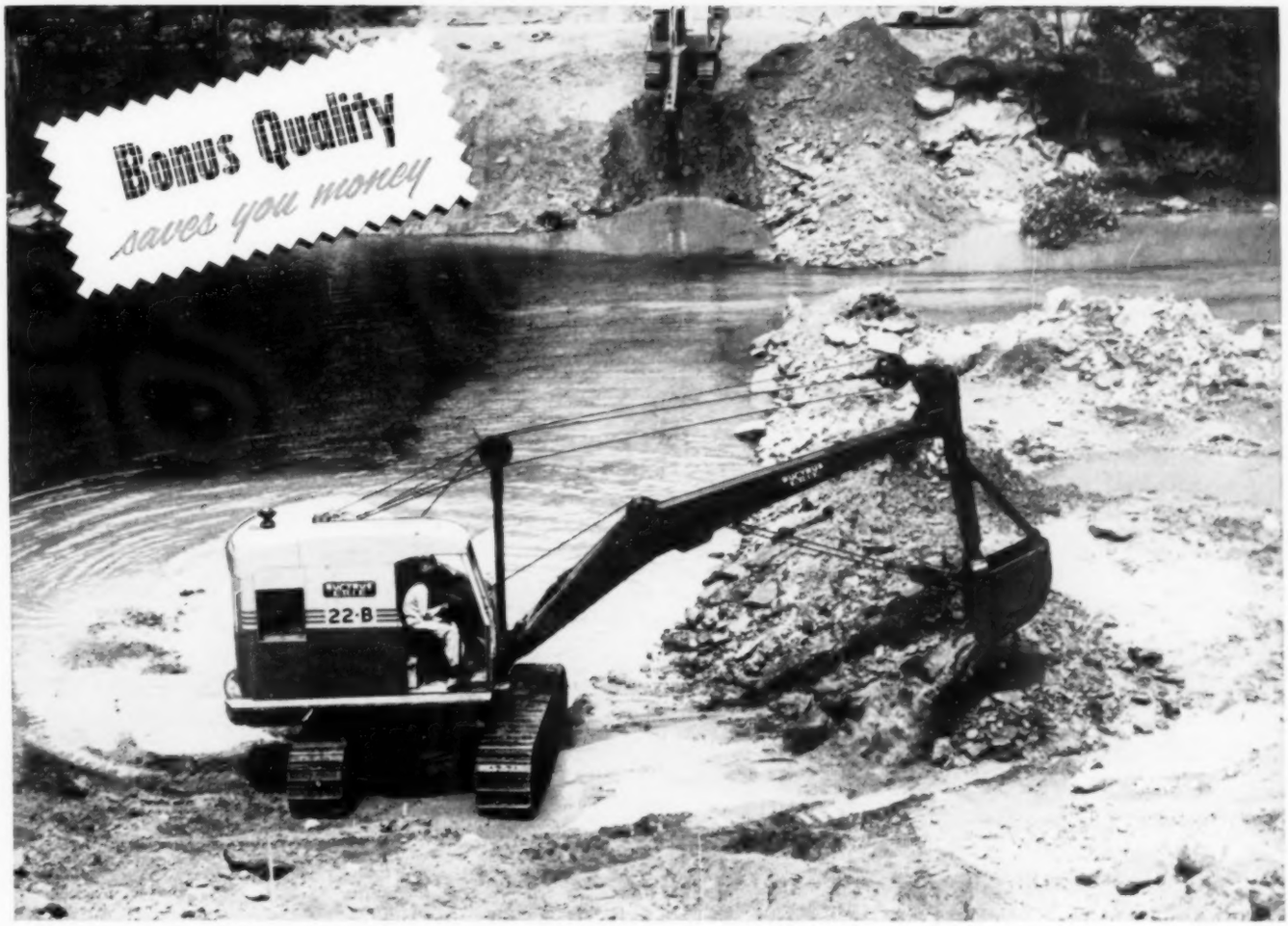
Inside the metal terminal box the ends of the test wires are fastened to threaded binding posts mounted to a phenolic block on the back of the box.

Tripod Supports Solve Ravine-Spanning Problems

One pipeliner has solved his ravine-spanning problems with a simple tripod arrangement which is both neat and practical.

The pipe is brought out of the ground with over bends to rest on two or three tripod supports as required. A strap clamp holds the pipe to a metal saddle which is mounted to the tripod.

Sections of scrap pipe may be used for the tripod legs. These are im-



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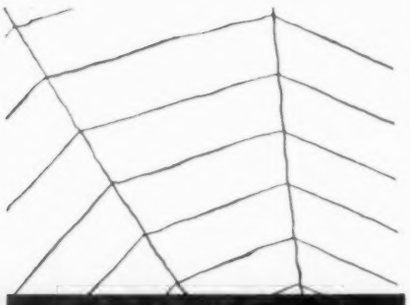

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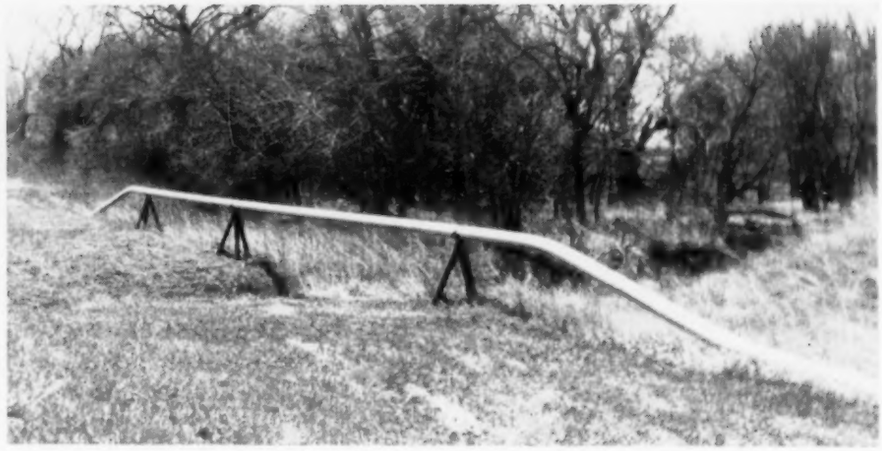
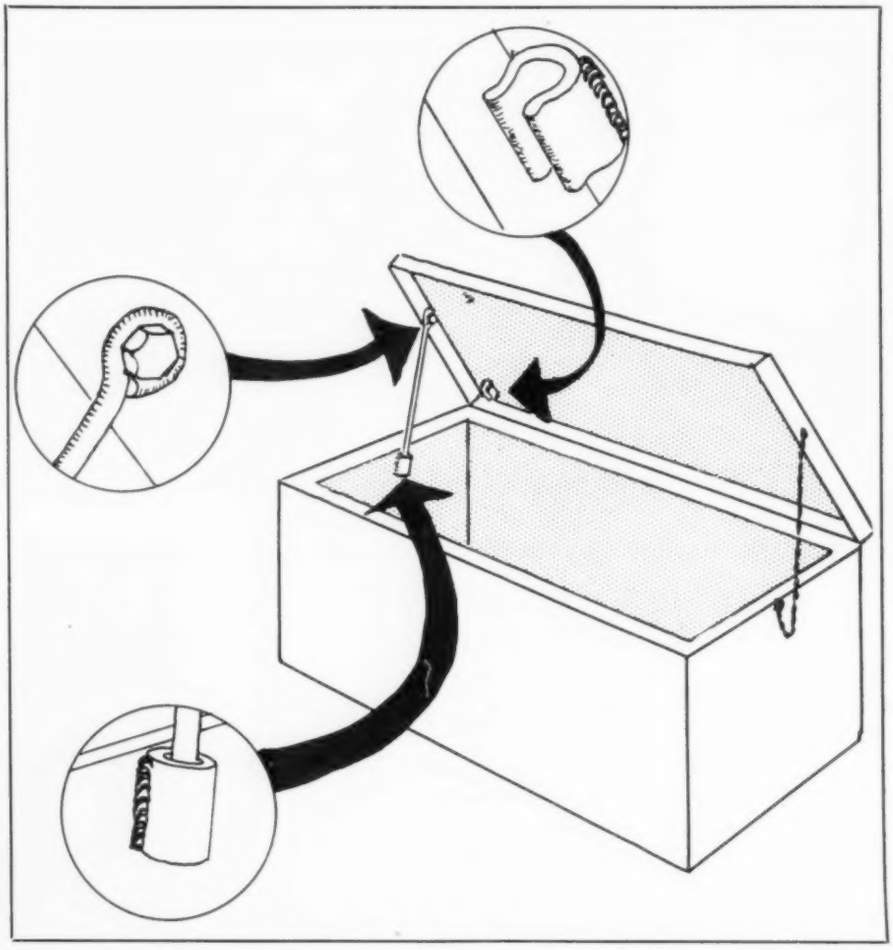


bedded in a concrete base for proper footing and anchorage.

If the line is under cathodic protection, special care should be taken to insulate the pipe from the tripod supports.



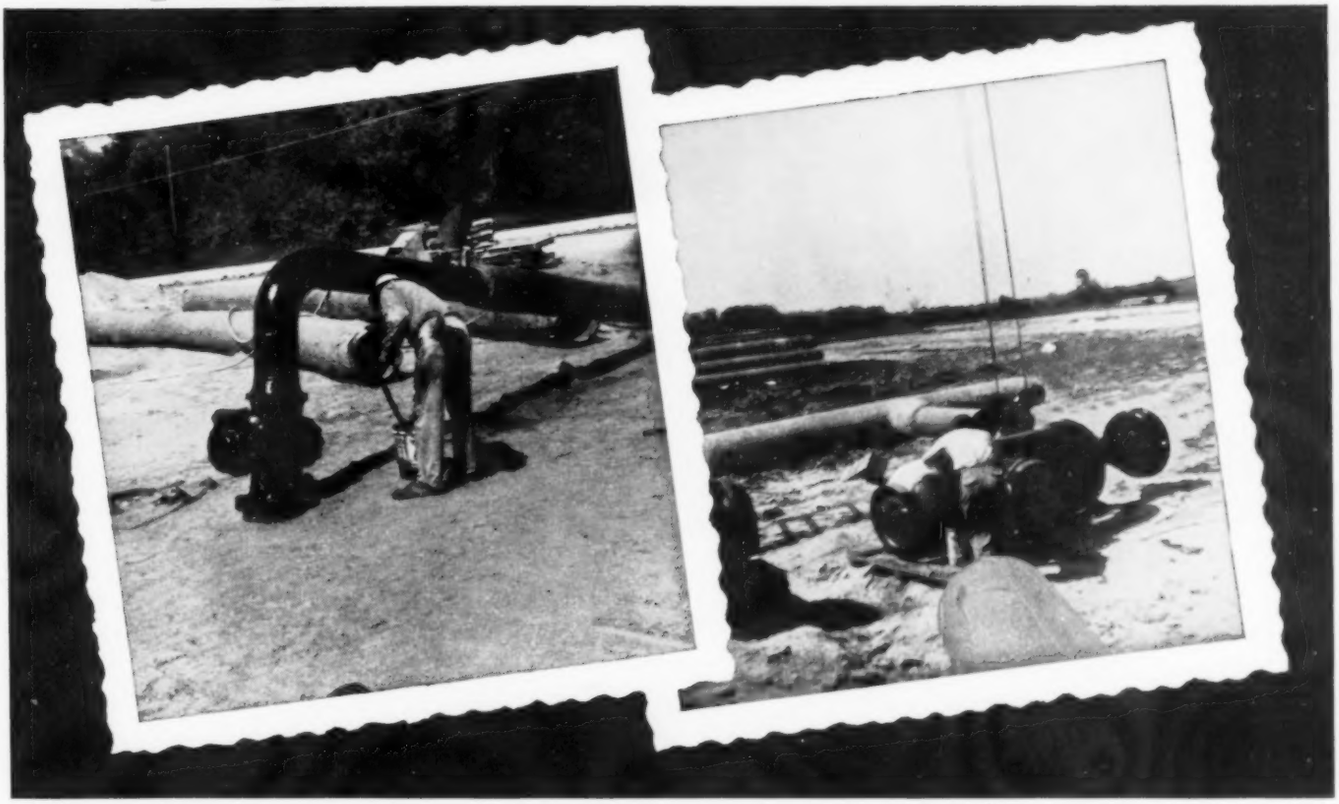
Install Simple Safety Catch On Tool Box to Avoid Injury

Heavy tool box lids can be dangerous if unsupported in the open position.

To eliminate this hazard to a man's fingers or hand, simple safety catches can be made and installed. The pictured device is composed of a small gage steel rod, sheet metal bracket, socket assembly, small chain, nuts and bolts.

The socket assembly is made from a piece of scrap pipe to one end of which is welded a metal cap.

TARSET® Protects Valves and Piping on T.G.T. "Muskrat" Line



New Pitt Chem Coal Tar-Epoxy Coating Selected for Maximum Protection in Rugged Marshland Area

In the swampy marshland terrain where Tennessee Gas Transmission Company is laying most of its new 24-inch "Muskrat" gas line, superior protection against corrosion becomes just as vital for above-ground equipment as for the underground line itself.

Relying on Pitt Chem Modified Enamel, in part, for underground main line protection, T.G.T. engineers specified another Pitt Chem product, new cold-applied *Tarset*, for the protection of main line gate valves, headers and other above-ground equipment on the gathering system.

Since the first application of Tarset in sour crude storage tanks, the use of this revolutionary coal tar-epoxy coating has spread rapidly to the gas industry and many others. *For no other cold-applied material available today offers such durable protection at such a moderate cost.*

What's *your* corrosion problem? Chances are this rugged, heavy-duty coating can help you solve it. *Write or call today for newest Tarset performance data and other helpful information.*

PITT CHEM® TAR BASE COATINGS

- Standard Grade
- Modified Grade
- Plasticized Grade
- Hotline
- Cold Applied Tar Base Coatings

PROTECTIVE COATINGS DIVISION
PITTSBURGH COKE & CHEMICAL CO.
Grant Building • Pittsburgh 19, Pa.

WSW 6195

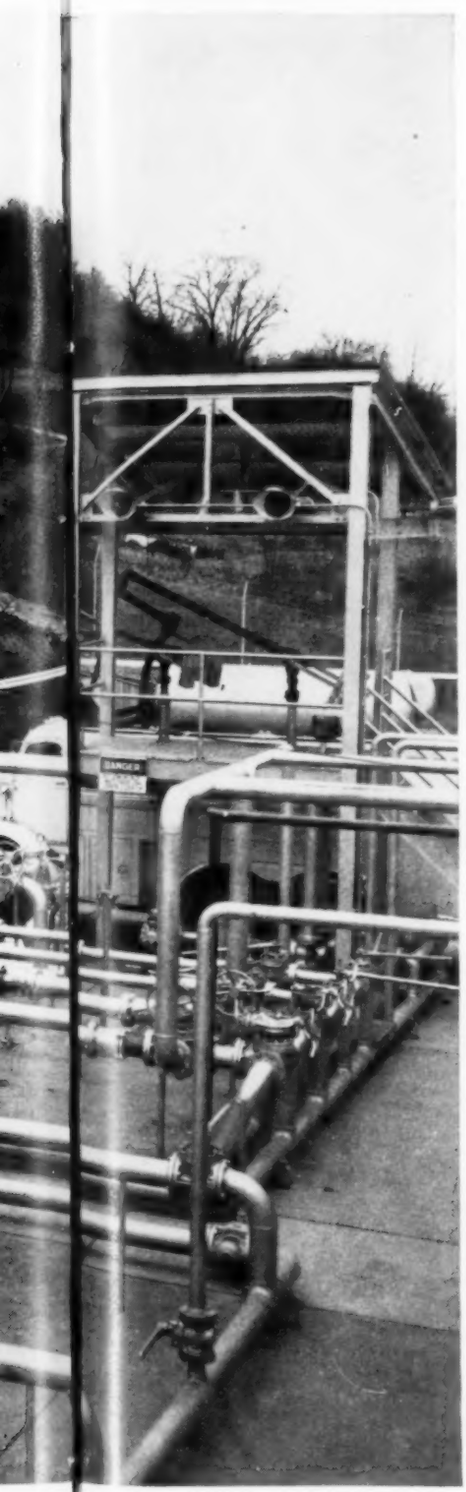
COAL CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON

How the Rockwell

OPERATING AREA IN ROCKWELL METER TEST STATION

In this unique plant—the world's largest—we test meters under every operating condition. We shock load and abuse them, to pre-prove their accuracy and durability.

Meter Test Station



Benefits You

Rockwell Meters are Job-Tested and Tailored to Your Service Needs

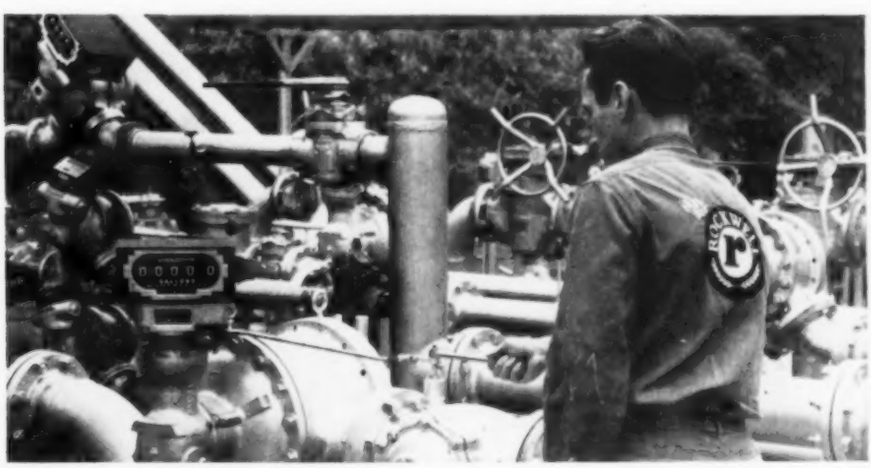
In the four-acre Rockwell test station, engineers can duplicate every field measurement condition. Here they exactingly test—yes, even torture meters under every conceivable degree of pressure, temperature and fluid viscosity. They make sure *and you can be sure*, the Rockwell meters you order will measure up to the specifications for your service.

This costly practice costs you nothing extra. It pays off in greater accuracy, longer meter life, less maintenance and lowered measurement costs. That is why it will pay you to make Rockwell Rotocycle meters your preference and save money on every job.

ROCKWELL MANUFACTURING COMPANY

PITTSBURGH 8, PA. Atlanta Boston Charlotte Chicago Dallas Denver Houston Los Angeles Midland, Tex. New Orleans New York N. Kansas City Philadelphia Pittsburgh San Francisco Seattle Shreveport Tulsa

In Canada: Rockwell Manufacturing Company of Canada, Ltd., Toronto, Ontario

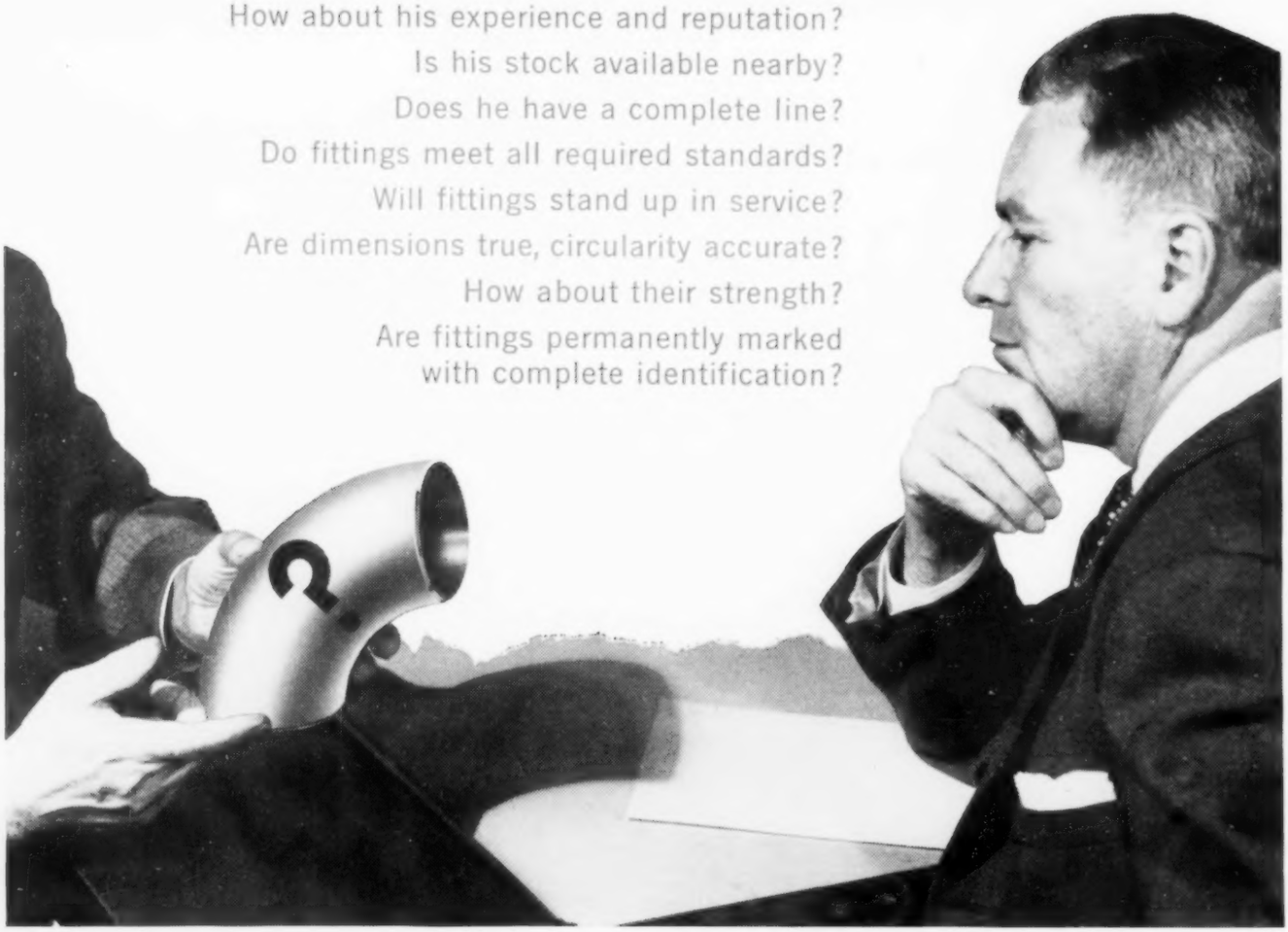


Operator conducts durability test on a model 6 BLX Rotocycle meter equipped with multi-stage control valve for a smooth pre-set closure.

Rockwell *ROTOCYCLE* Meters

For more data on advertised products, use Readers' Service Cards, last page.

Is the manufacturer a piping specialist?
Can he help us in engineering?
How about his experience and reputation?
Is his stock available nearby?
Does he have a complete line?
Do fittings meet all required standards?
Will fittings stand up in service?
Are dimensions true, circularity accurate?
How about their strength?
Are fittings permanently marked with complete identification?



No unanswered question...no risk

when you buy known fittings

You save purchasing time and avoid trouble later on when you buy TUBE-TURN* Welding Fittings and Flanges. Made in U.S.A. by the leader in the field, these products give you top quality and uniformity, backed by unmatched engineering service and nearby complete-line distributor facilities. They meet *all* American Standard and Safety Code requirements. Each product is permanently identified by the "TUBE-TURN" trademark with complete size and material designation.

You can't get a better bargain in welding fittings and flanges than from your trusted Tube Turns' Distributor!

The Leading Manufacturer of Welding Fittings and Flanges

*"TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Detroit • Chicago • Kansas City • Denver
Los Angeles • San Francisco • Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

Stand Keeps CO_2 Bottle Handy Around Station

This stand for a carbon dioxide extinguisher was fabricated from 4-inch pipe imbedded in a neat concrete base. The holder and door were made by cutting a section of 12-inch pipe as shown. Flat stock was used for the base and top of the extinguisher.

The entire assembly was fabricated and set into the concrete base. Hasp and pin allow the stand to be kept closed against the weather, yet the fire extinguisher is readily accessible when needed.

Old Brake Drum Makes Holder for Water Can

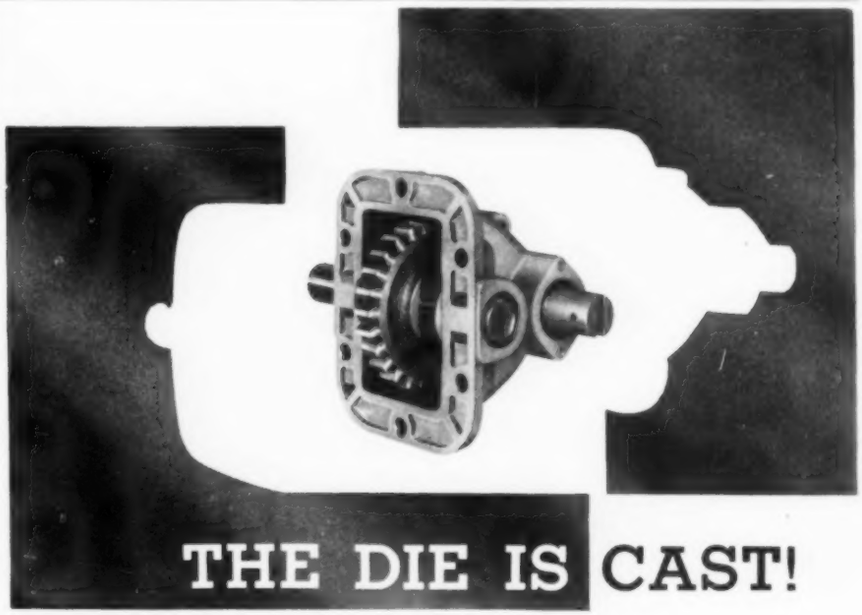
A salvaged brake drum provides a good holder for the water can on a field truck. The holder is installed on the running board of the truck as shown. The drum has enough taper to allow the can to be wedged in place without any other fittings needed.

To attach the drum to the running board, place bolts through three of the holes normally used to fasten the brake drum on an axle. Mating holes through the running board and nuts and washers complete the installation.

Bands On Posts Mark Route to Right-of-Way

Can't pin down spread location for truck drivers and others hunting the right-of-way? Try this simple method and no map is necessary.

When driving out to the new location, place a band of cloth or cardboard around a telephone pole or fence post at each point along the



THE DIE IS CAST!

IT'S THE DIE-CAST ALUMINUM HOUSING FOR THE NEW TULSA® SINGLE SPEED, MEDIUM DUTY POWER TAKE-OFF!

The die-cast aluminum housing makes this NEW TULSA power take-off "light as a feather" . . . gives it all the strength and durability for which the TULSA line is famous. Output shaft rotates on two needle bearings and is manufactured in three sizes—13/16″, 7/8″ and 15/16″. It's available with either cable or lever control. Designed and built to cover the full market range of a thoroughly dependable, low priced, single speed power take-off for medium duty work. Same nationwide distribution and service as offered for the full TULSA line of power take-offs.

Tulsa Winch
TULSA, OKLAHOMA DIVISION OF VICKERS Inc.

For more data on advertised products, use Readers' Service Cards, last page.

In Pipeline Service...

MAKE SURE YOUR SMALL PIPING IS JOINED SAFELY, TOO

■ W-S Forged Steel Fittings provide safe, tight connections for your small diameter, high pressure piping. In gathering lines . . . pump and compressor piping . . . instrument lines and other high pressure lines, 4" and under in diameter, W-S fittings protect you against costly down-time. They're drop-forged for extra strength and toughness—and they're safety-factor designed.

Watson-Stillman Fittings are available in screw-end and socket-welding types in carbon steel, stainless steels and alloy steels. Send for your copies of our informative catalogs.

W-S FITTINGS DIVISION

H. K. PORTER COMPANY, INC.
Roselle, New Jersey

HINTS . . .

route where a turn is necessary.

The band should be brightly colored for easy recognition. By placing this band on the inside of each turn, the drivers will know where and in which direction to turn.

This greatly simplifies giving directions. Instead of the usual time-consuming and necessarily vague route explanations, the drivers need only be told to drive out a given highway and turn around each band until the spread is reached.

Keep Emergency Flares In Locked Bumper Can

Emegency flares that should be standard equipment on a pipeliner's truck are often misplaced or used and not replaced. One truck driver corrects this situation by welding a flare container on the front bumper of his truck as shown.

The container is kept locked when flares are inside. When the last flare is used, the driver places the lock inside the container and leaves the container unlocked as a reminder to replace the flares as soon as possible.

To make the container, a plate is welded to one end of a section of 8-inch pipe. A hinged plate with hasp attaches to the other end. This assembly is welded to the truck's front bumper.

The key to the container's lock is kept on the ignition key ring so the driver always knows where the emergency flares are and when they need replacing.

For more data on advertised products, use Readers' Service Cards, last page.

Design Factors in Telemetering Systems

Four important points to consider in planning for remote measurement or recording

A BRISTOL APPLICATION NOTE

Telemetering systems provide a proven way to keep tabs on a remotely located process, pipe line, service or utility. In fact, any time remote indication recording, or control is required, telemetering can serve your needs.

Here are the four conditions which must be considered in selecting the best telemetering system for any installation.

1. VARIABLES

Most industrial variables can now be measured, computed, and converted into a form that can be transmitted electrically. Their number and variety influence circuit complexity and the appearance of the receiving panel. Some variables now being successfully telemetered include:

Pressure • Current and voltage • Temperature • Flow • Electrical power • Wind velocity • Liquid level • Motion • BTU's • pH Horsepower • Speed

2. FREQUENCY OF READING

While the majority of telemeter systems in service today are the point-to-point continuous recording type, complex networks and interrelated variables are making sophisticated approaches more and more necessary. The problem usually boils down to these questions: how often is measurement necessary, and what is the least costly way to install and run the system?

Five types of possible hook-ups are:

Continuous recording—where variables are critical and need constant watch.

Intermittent indicating—where variables need only be checked at intervals.

Continuous-Intermittent—where it is possible to separate more critical variables for constant and intermittent telemetering.

Grouped-Multiplex—where several measurements can be transmitted as a group over a single circuit into a "multiplexed" receiver.

Successive-Multiplex—where measuring points over a large area can be "multiplexed" at intermediate locations, then herded to the panel.

3. TERRAIN

The type of interconnecting circuit between the measuring transmitters and central panel usually depends on the terrain: its topography, weather, and degree of settlement. Hence, signals may be carried by one, or by combinations, of the basic transmission media:

Radio—various types of radio can be used to take signals over mountains, deserts, and seas.

Wire—strung wire or leased lines can cover plant, urban, and rural areas.

4. INSTRUMENTATION

Bristol Metameter® Telemeters are eminently adapted to any of the conditions of measurement frequency, variables, or terrain likely to be encountered in telemetering. Transmission can be provided over telephone circuits, carrier current, radio—including microwave, VHF and UHF—and private wires, multiplexing and selective calling. Under all sorts of conditions, thousands of installations, ranging from just a few to hundreds of instruments each, have proven the dependability and reliability of Bristol Telemeters—pulse width (or duration), differential transformer, and voltage types, as well as pneumatic systems.

For more information on how Bristol Telemeters can benefit *you*, write THE BRISTOL COMPANY, 114 Bristol Road, Waterbury 20, Conn. 5.44

TYPICAL RECEIVING CENTER in multiplexed telemetering system.

BRISTOL *POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Pipe Line Men

IN THE NEWS

Joe C. Darrow

A. P. Rowland

Joe C. Darrow, a vice president at **Lone Star Gas Company**, has been placed in charge of all distribution properties of the company. The properties consist of company-owned and operated gas systems in 451 cities and towns in Texas and Oklahoma. Darrow has served as general manager of the Fort Worth division of distribution from 1951 until 1954, when he was elected vice president in charge of the division.

A. P. Rowland, 32-year employe with Lone Star, has been elected to succeed Darrow. Rowland became assistant general manager of the Fort Worth division last year after serving 17 years as regional manager of the company's South Texas region of distribution.

•

Texas Gas Corporation has named **Dr. Willard M. Dow** director of research. Dow comes to Texas Gas from United Gas Corporation where he was assistant director of research. Dow received his master of science degree and his Ph.D in gas technology and chemical engineering at the Institute of Gas Technology, affiliated with the Illinois Institute of Technology.

•

Joe W. Hancock has been named superintendent of drilling for **Natural Gas Pipeline Company of America** succeeding **Charles I. Galloup,** who retired. Prior to his promotion, Hancock was assistant superintendent. He has been with the company for 20 years. He also served for a time as production and drilling superintendent for a subsidiary, **Natural Gas Storage Company of Illinois.**

E. J. Hyde, general superintendent of the Central district for the Pipe Line department of **Standard Oil Company of California,** has been named assistant manager of the department. Hyde succeeds **J. S. Grepe, Jr.,** who retired June 1 after 43 years of service with the company. Hyde joined Standard's Pipe Line department in 1938. He became a foreman by 1945 and was named organization and personnel specialist for the department in 1948. Grepe joined Standard in 1913 and was named manager of Pasotex Pipe Line Company, El Paso, in 1928. He returned to Standard's Pipe Line department in 1932.

C. L. Reasoner will succeed Hyde as general superintendent, Central district, Pipe Line department.

•

Pacific Northwest Pipeline Corporation has selected Salt Lake City, Utah, as permanent operating headquarters for the firm. Officials of Pacific Northwest who will move from the present offices in Houston to Salt Lake City are **C. R. Williams,** president; **R. C. Frederick,** vice president; **Allen B. Hiatt,** vice president; **A. B. Allyne,** vice president; **J. M. Clark,** vice president; and **C. A. Watson,** treasurer.

•

D. A. Hardesty has been elected assistant vice president of the **Natural Gas Pipeline Company of America** and its affiliate, **Texas Illinois Natural Gas Pipeline Company.** He heads employe and public relations activities for the organization. A 21-year veteran in the transmission industry, Hardesty is vice chairman of the Employe Relations Section of the Southern Gas Association and vice chairman of the Employe Relations Committee of the Independent Natural Gas Association of America.

D. A. Hardesty

Kenneth E. Tappy, former superintendent of the **Ohio Oil Company's** Lima, Ohio, Pipe Line division, has been appointed superintendent of the Wyoming Pipe Line division in Casper, Wyo. Tappy succeeds the late Clare McElhinny. The Lima division now will be included in the Martinsville, Ill. division. W. K. Smith, superintendent of the Martinsville division, will continue as head of the expanded division.

Kenneth E. Tappy

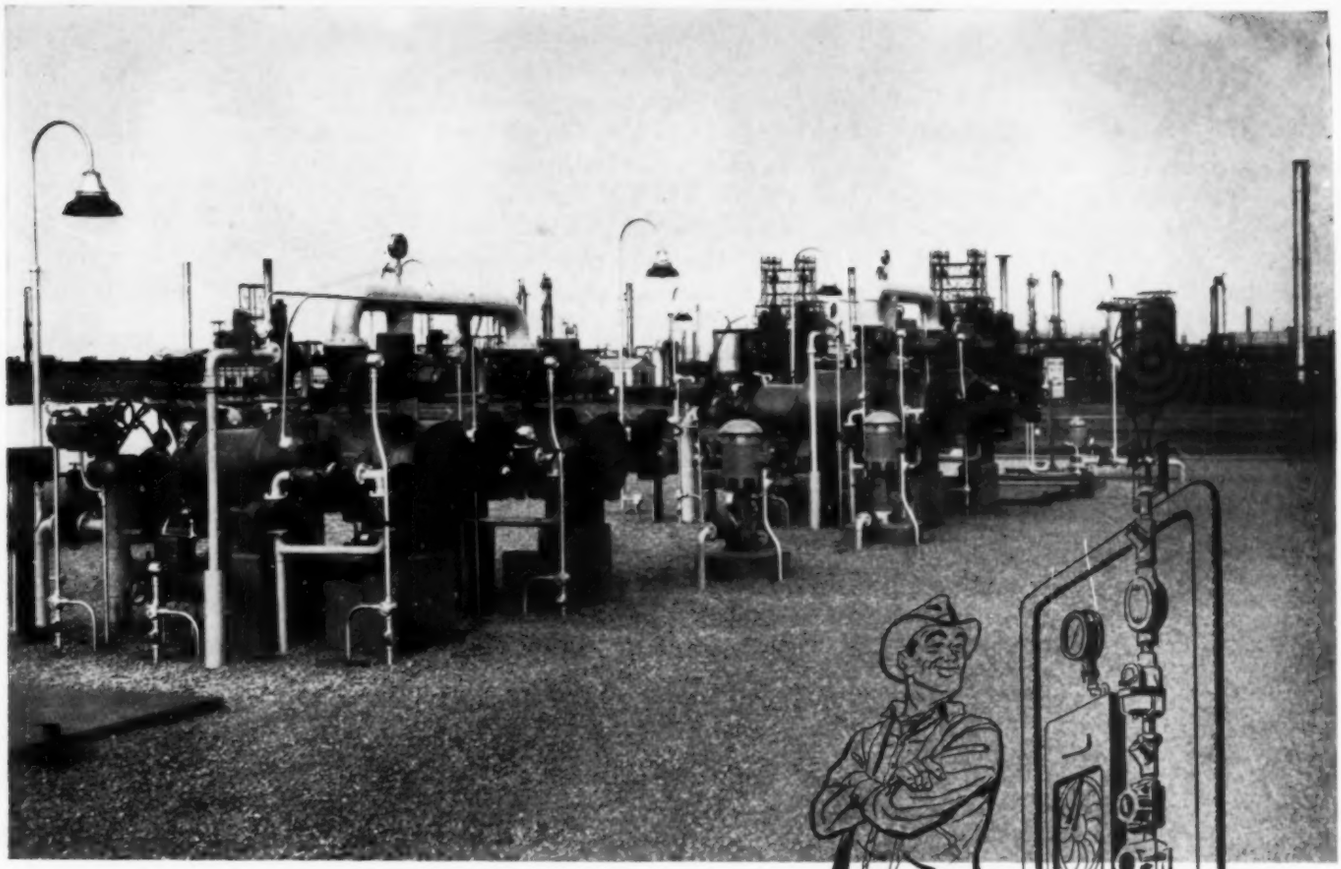
Tappy joined Ohio Oil in 1933 as an assistant fireman at the Ferry pipe line station near Buffton, Ind. In 1938 he was made line foreman on the line between Bluffton and Lima, Ohio, and the next year he became chief engineer at Ohio Oil's Watt Station, Lima. Tappy became assistant superintendent of the Lima pipe line division in 1940 and superintendent in 1952.

•

Tidewater Oil Company has announced the appointment of **Robert J. Menzie,** formerly with the Federal Power Commission in Washington, D. C., as senior engineer in the Gas Utilization department of the company's Southern division headquarters in Houston. Menzie was with the FPC 5½ years and was supervising general engineer specializing in gas matters before resigning to join Tidewater.

•

James D. Thompson has been appointed to succeed **John M. Dillon, Jr.,** as superintendent of **Shell Oil Company's** gas plant at Elk City, Okla. Dillon is promoted to gas manager of the Calgary exploration and production area in Alberta, Canada. He has headed plant operations at Elk City since 1953. Thompson has been a gas engineer in Shell's Tulsa office for the past two years.



How to filter refined products

...without so much as lifting a finger!

Jet Strainers offer three distinct advantages over all others:

(1) They strain all of the product . . . all the time, requiring minimum stand-by capacity. This means that it is never necessary to by-pass any of the dirty product. Thus, metal seals, bearings and other vulnerable pump parts cannot be damaged by solids entrained in the product. Metering equipment is likewise protected against damage.

(2) Jet Strainers filter the product to any desired degree. Stainless steel strainer baskets are available in mesh sizes up to 400. Filter-aids may be used to further improve the brightness of the product.

(3) Since Jet Strainers are self-cleaning, automatic controls may be applied to the strainers to make their operation fully automatic if desired. Even semi-automatic Jet Strainer operation reduces the process to push-button control and manual opening and closing of a few valves.

The whole story on Jet Strainers has been prepared in booklet form. A copy will be sent gladly on request.

THORNHILL-CRAVER CO.
P. O. BOX 1184 HOUSTON, TEXAS

JET STRAINER

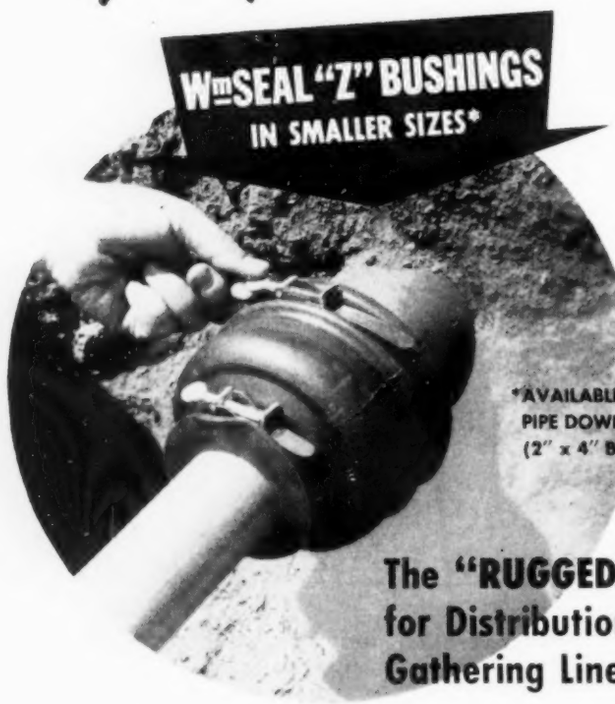
Strains all the product ...all the time

For more data on advertised products, use Readers' Service Cards, last page.

Sharman, Allen, Gay & Taylor, Inc., recently-formed pipe line contracting firm, has moved into new offices in the Bayou building, Houston. The firm presently is completing work on Tennessee Gas Transmission Company's Muskrat line in Louisiana. The newly-formed organization will contract for laying all sizes of natural gas, crude, products and water pipe lines, submerged river crossings, overhead crossings of suspension and rigid frame type.

J. W. Sharman, president, formerly was with Latex Construction Company, Houston Contracting Company and Associated Pipe Line Contractors Inc. **John M. Gay** formerly was with Panhandle Eastern Pipe Line Company, Fish Engineering Company and Associated Pipe Line Contractors, Inc. **S. A. Taylor** was connected with Panhandle Eastern Pipe Line Company, Trunkline Gas Company, Gulf Interstate Gas Company and Associated Pipe Line Contractors, Inc.

By Popular Demand!



The "RUGGED" Casing Seal for Distribution and Gathering Lines

Check these features and compare

- **NO JOINT.** SOLID RING OF TOUGH SYNTHETIC RUBBER
- **HAND TIGHTENED.** NO TOOLS REQUIRED TO INSTALL
- **NO SHIELD REQUIRED.** EXTRA THICK, WITHSTANDS WEIGHT OF BACKFILL EARTH

T. D. Williamson, Inc.

P. O. BOX 4038 — TULSA 9, OKLAHOMA

REPRESENTATIVES: Houston • Pittsburgh • Plainfield, N. J. • Amarillo • Casper • Provo, Utah Joliet, Illinois • Los Angeles • San Francisco • Bartlesville, Okla. • Seattle • Edmonton London, Ontario • Calgary • Buenos Aires • Durban, Natal, South Africa • Paris, France

Earl Ainsworth

Robert E. Baker, Jr.

Earl Ainsworth has been named assistant to the manager of gas purchases for **Northern Natural Gas Company.** A veteran of 27 years in the oil and gas industry, Ainsworth has been with Northern since 1949 and has worked on production and gas supply activities.

•

Robert E. Baker, Jr., has been appointed vice president—operations and elected to the board of directors of **General Gas Corporation.** Former manager of Ernst & Ernst's Management Service division in Houston, Baker served as production manager of Ruska Instrument Corporation before 1948.

•

Ralph B. McLaughlin, chairman of the board of **The Texas Pipe Line Company,** and chairman of the board of three Texaco affiliated companies has completed half a century of employment. On July 1 he retired as chairman of board of Texas-New Mexico Pipe Line Company, Texaco-Cities Service Pipe Line Company and Kaw Pipe Line Company. He will retire from Texas Pipe Line Company September 1.

R. B. McLaughlin

McLaughlin joined The Texas Company as a pipe cleaner in the warehouse yards in Sour Lake, Texas. He was promoted successively to clerk and auditor and became assistant secretary of Texas Pipe Line Company when it was formed in 1917. Progressing in management positions, McLaughlin became president of Texas Pipe Line in 1947 and chairman of the board five years later.

Pumping Progress Report

FOR PIPE LINE ENGINEERS

An advertisement prepared by the Aldrich Pump Co., Member of Hydraulic Institute, U.S.A.

PUMPING LIQUID BUTANE AND PROPANE is a typical operational headache successfully handled by the Aldrich Pump Company Engineers. It was a particularly tough pumping problem for one large pipe line company; they had to move butane 186 miles — from a Texas oil field to a Gulf Coast refinery.

PUMPING LIGHT-GRAVITY FLUID AT HIGH PRESSURES required the positive displacing action of conventional reciprocating pumps plus the flexibility of capacity provided by centrifugals. And Aldrich Engineers knew the answer — the Aldrich-Groff Controllable Capacity "POWR-SAVR" Pump.

STEPLESS STRAIGHT LINE CONTROL OF CAPACITY, from zero to rated maximum output, was possible with the "POWR-SAVR". Pump delivery was automatically controlled to suit varying requirements and power consumption became nearly proportional to the rate of output, affording desirable power savings.

SURGE TANKS WERE ELIMINATED, due to the "POWR-SAVR's" ability to meet immediate changing line conditions. This eliminated associated evaporation losses, co-mingling of different batches, and much of the danger of handling highly flammable material. Gone, too, was the need for bypassing to handle excess quantities of pump output.

UPRIGHT DESIGN of the "POWR-SAVR" places discharge valves directly over the plungers and inlet valves at one side. Efficient valve action permits the pump to operate at the high rate of 240 rpm. Another design feature was the use of porcelain plungers, reducing packing and leakage troubles.

THE ALDRICH PUMP COMPANY has been solving the difficult pumping problems of American industry since 1902. We've never turned down a challenge — many of yesterday's tough pumping problems are today routine.

DATA SHEET 65A, describing the Aldrich-Groff Controllable Capacity "POWR-SAVR" Pump will be sent to you on request. Or our representative will be glad to call. Address your request to: The Aldrich Pump Company, 6 Pine Street, Allentown, Pa. (Advertisement)

Aldrich-Groff Controllable Capacity "POWR-SAVR" Pump suitable for pumping butane and other light-gravity fluids.

...for your tough pumping problems specify ALDRICH

This machine is ideal for pumping light-gravity fluids at medium and high pressures. It combines features of superior efficiency and positive displacing action of reciprocating pumps with the flexibility of capacity of centrifugal pumps. A unique, reliable mechanism controls the plunger-stroke from zero to rated output without change of speed of power source, providing desired savings in power plus top efficiency.

Typical Applications for the Aldrich-Groff "POWR-SAVR" Pump:

Pipe Line Service — **Process Charging**
Boiler Feeding — **Oil-burner Supply**

Write for Data Sheet 65A, describing the features of the "POWR-SAVR" Pump. Or, if you prefer, our representative will be glad to call.

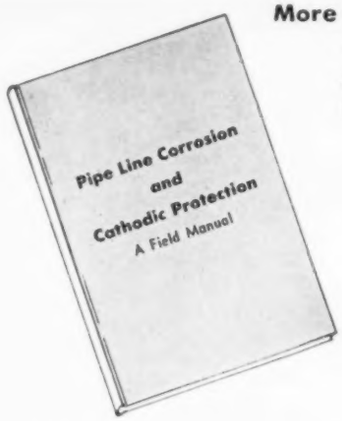
THE ALDRICH PUMP COMPANY

Originators of the Direct Flow Pump
6 PINE STREET
ALLENTOWN, PA.
Representatives in principal cities

For more data on advertised products, use Readers' Service Cards, last page.

More comments on this new Handbook:

"... a most practical on-the-job manual for men concerned with pipe line corrosion. We are ordering copies for each of our district engineers."



Pipe Line Corrosion and Cathodic Protection

By MARSHALL E. PARKER

This Handbook, written by Marshall E. Parker, consultant, is designed as a practical field manual. It is a 108-page pocket-size volume printed first as a popular series in WORLD OIL. The Handbook is illustrated with many charts and drawings and is completely indexed by subjects.

It presents comprehensive data on Soil Resistivity Surveys, Potential Surveys, Line Currents, Current Requirements, Rectifier Systems, Ground Bed Design, Magnesium Anodes, Stray Current Electrolysis, Interference in Protective Systems, Operations and Maintenance, and Coating Protection and Testing.

An appendix has been added of technical data on Underground Corrosion, Basic Principles of Cathodic Protection, Properties of Metals and Attenuation Equations. Order copies of this practical Field Manual now for each of your field men. Price $3.

Send for your FREE copy of the New Petroleum Book Catalog which describes the nature and contents of many books pertaining to the Petroleum Industry.

ADDRESS:

Book Department
GULF PUBLISHING COMPANY
P. O. BOX 2608
HOUSTON 1, TEXAS

NEWS FOR PIPELINERS

NOW . . . the best of PIPE LINE INDUSTRY'S How-To-Do-It Hints are available in Handy Workbook form

This easy-to-use Workbook shows you hundreds of practical time-and-money saving ideas developed by pipeline men on the job. These ideas can be put to use during those slack periods in production time.

Every idea . . . every shop-made item in the Workbook is fully explained and illustrated. Guesswork is eliminated . . . you get the "meat" of how to do your job faster and better. You'll have—at your fingertips—answers to difficult labor-consuming problems in pipeline construction, design, operations, maintenance, engineering, communications, corrosion and safety.

Available for only $1.00 a copy, the Workbook can be obtained by addressing:

PIPE LINE INDUSTRY

P. O. Box 2608, Houston 1, Texas

E. Clyde McGraw, executive vice president of **Transcontinental Gas Pipe Line Corporation,** has been named to the board of directors. Other Transco directors besides McGraw, are **Clyde H. Alexander,** Dallas; **Alfred C. Glassell, Jr.,** Houston; **N. V. Kinsey,** Shreveport; **Benno C. Schmidt,** New York; **Franz Schneider,** New York; **Joseph J. Snyder,** Boston; and **Tom P. Walker,** Houston.

E. Clyde McGraw

Before joining Transco in 1950, McGraw was vice president of Stone & Webster Service Corporation in New York, serving as advisor to natural gas companies. He served Transco as vice president—operations and in 1955 was named executive vice president. •

Leslie J. Clisham has completed 35 years of service with **Shell Oil Company.** Starting as a clerk in 1921, Clisham is now in Shell's Los Angeles headquarters as manager of crude oil and products in the Transportation and Supplies department. Clisham has spent his entire Shell career in California. He assisted in opening the refinery at Wilmington in 1923, then moved to San Francisco as manager of the Supplies department. •

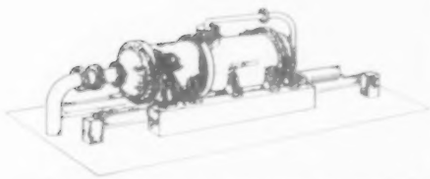
A. A. Corona, vice president of **The American Oil Company,** has assumed greater responsibilities with the recent organization of a new Supply and Transportation department. The department was set up to handle expanding operations in the supply and movement of crude oil and products throughout its marketing territory. Corona has headed the former Supply and Distribution department since it was organized in 1947. **Sam H. Casey,** former general manager of supply and transportation of Pan-Am Southern Corporation, has been appointed to a new post as Amoco's first general manager of supply and transportation. **I. W. Fariss,** formerly crude and refinery coordinator, has been promoted to general supply manager; **John M. Whelan** continues as general traffic manager; and **Verne N. Drew** is general manager of marine operations.

More than 325,000 horsepower of

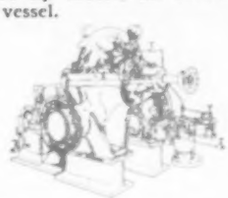
I-R CENTRIFUGAL COMPRESSORS

for NATURAL GAS SERVICE

I-R *"FIRSTS"* in Centrifugal Gas Compressor History



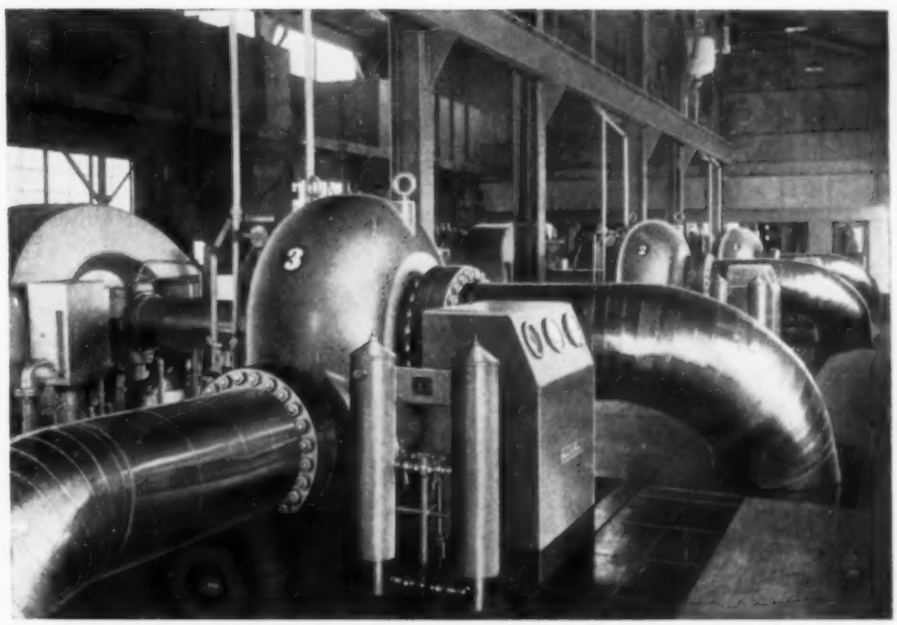
FIRST CENTRIFUGAL PIPE-LINE COMPRESSOR Built by Ingersoll-Rand in 1931, this centrifugal pipe-line booster consists of a six-stage compressor driven by a 3550 rpm, 3000 hp motor, all encased in a pressure vessel.



FIRST COMMERCIAL APPLICATION of centrifugal pipe-line compressors was made in 1947. A total of 78 electric-motor-driven, single-stage I-R centrifugals were installed, to handle approximately 250 mmcfd.

FIRST GAS-TURBINE-DRIVEN UNIT Installed in 1949, this Ingersoll-Rand centrifugal compressor, powered by an 1850 hp simple cycle combustion gas turbine, was the first gas-turbine-driven centrifugal compressor developed and applied to pipeline service, and was designed for a flow of 192 mmcfd at a ratio of 1.18.

FIRST 2000 PSI CENTRIFUGAL GAS COMPRESSOR This Ingersoll-Rand 5000 hp double-case centrifugal compressor was the first unit ever built for handling natural gas at a discharge pressure of 2000 psi.



Three of 8 Ingersoll-Rand centrifugal compressors installed on a large natural gas pipe-line. Each unit is driven by a 5000 hp gas turbine.

This experience means MAXIMUM DEPENDABILITY in modern pipe-line service

FROM the very first pipe-line installation, Ingersoll-Rand has pioneered in the development of centrifugal gas compressors for higher and higher capacities and pressures. And every step of the way, dependability of performance has been a prime consideration in every detail of design and construction. This is why more I-R Centrifugal Compressors have been sold for natural gas service than any other make . . . . a total exceeding 325,000 hp for this service alone.

Backed by such long and successful experience, the modern I-R centrifugal gas compressor is your best assurance of trouble-free performance and long-range economy in gas transmission service.

Ingersoll-Rand

11 Broadway, New York 4, N. Y. 12-319

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO-BLOWERS CONDENSERS
CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

For more data on advertised products, use Readers' Service Cards, last page.

Here the new 75-drawbar-hp HD-11, (25,470 lb as illustrated), teamed with another Allis-Chalmers crawler, starts up the mountain from the "shoefly" pulling a pipe truck. Distance up the slope was 1,175 ft. A man could not climb more than 200 feet of the entire trip.

Allis-Chalmers Crawler Tractors Whip Rocks and Razorbacks on "Wilderness Road" Pipe Line

H. B. Ranier Company pushes 12-inch line through Kentucky's roughest terrain

Nicknamed "Wilderness Road," the 31 miles of 12-inch gas line between Osborn Gap, Virginia, and Maytown, Kentucky, was one of the toughest pipe jobs ever handled by H. B. Ranier Construction Company, Prestonsburg, Kentucky.

Ranier's spread, headed by nine Allis-Chalmers dozer and side boom tractors, gouged the right-of-way out of steep razor-back slopes that were 80 percent rock. Often the rock cliff terrain was so steep that one crawler was used to hold another with a winch line for dozing out the right-of-way or lowering in the pipe.

Allis-Chalmers Crawler Ranier's Personal "Car"

On much of the line, a tractor was the only vehicle used — transporting men and supplies in addition to regular work. In fact, contractor Ranier used one of his Allis-Chalmers crawlers to drive up and down the line on inspection trips.

This powerful, new Allis-Chalmers HD-16 with angledozer is holding a backhoe with a winch as it works down a steep grade. Note the steep right-of-way in background. HD-16 has 125 drawbar hp, weighs 37,677 lb, as illustrated.

An anchor line for safety is hooked on to this HD-16 as it dozes rock out of the trench. This is the type of material the tractors dozed out on most of the job.

Sure-footed Allis-Chalmers side boom tractors like this machine handled pipe sections for dope machines and lowered pipe into trench.

Tractors Stand Up

Ranier stated, "Allis-Chalmers tractors have many advantages, but the biggest is the way they hang in there day after day without downtime. The fact that these tractors stood up so well helped us get faster pipe footage in spite of the terrain and the weather."

Allis-Chalmers Crawlers Get Operators' Vote

Ranier's tractor operators, to a man, preferred Allis-Chalmers machines. One said, "Those 'HD's' will climb where other makes have to be winched up a steep grade. On these hills, it's the only machine that'll pull its own weight and something along with it."

Make Your Own Test

Find out for yourself why pipeliners like H. B. Ranier equip their spreads with advanced-design Allis-Chalmers crawlers. Check any model from the big HD-21, through the HD-16 and HD-11 to the versatile HD-6 — they're all designed to give you faster pipe footage at less cost.

ALLIS-CHALMERS, CONSTRUCTION MACHINERY DIVISION
MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

For more data on advertised products, use Readers' Service Cards, last page.

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ALLIS-CHALMERS

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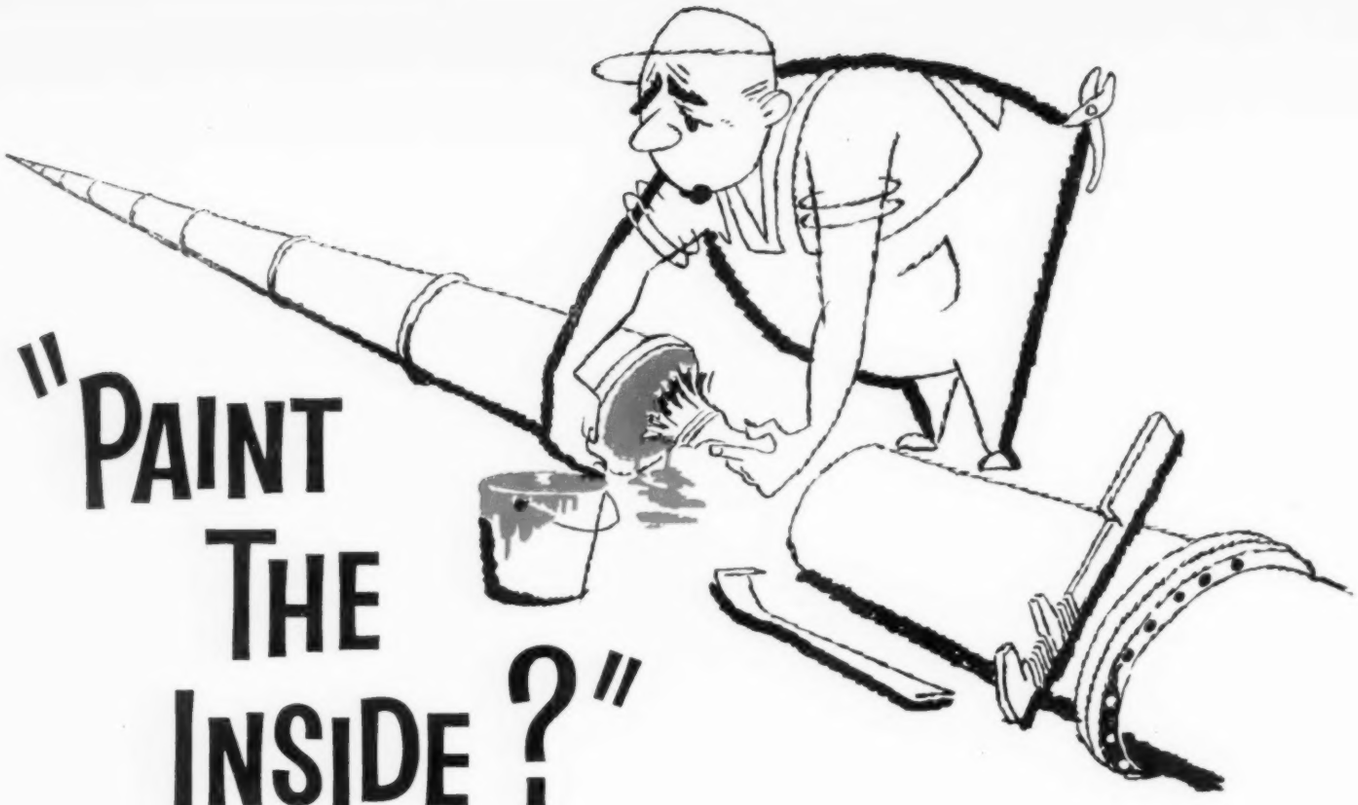


"PAINT THE INSIDE ?"

Sure you can "paint" the inside of your pipe line, but you don't need a brush (or a scraper) with UNICOR®.

UNICOR, UOP's oil-soluble corrosion inhibitor, added at a concentration as low as 10 ppm., will in effect make a rust-preventive oil of your product.

This makes UNICOR economical, providing vital protection for your pipe line at an inhibitor cost of about $0.0005 per barrel. UNICOR will scour your pipe line and coat it with a film that repels moisture and sludge.

Economies which result from reduced scraper and filter maintenance will more than pay for the inhibitor. This means that you actually get free protection for your pipe line.

Our experienced technologists will be glad to assist you in the design, installation and operation of a UNICOR system of protection. Write us for complete information and samples.

PRODUCTS DEPARTMENT

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD
DES PLAINES, ILLINOIS, U S. A.

WHO'S MEETING WHERE

American Gas Association, API, Canadian Petroleum Association, Committees on Natural Gas Reserves, Banff, Alta., July 9-11.

North Dakota Oil & Gas Association, Annual Meeting, Bismarck, N. D., August 20-21.

Sixteenth Annual Gas Measurement Short Course, West Virginia University, Morgantown, W. Va., Aug. 27-29.

Independent Natural Gas Association of America, St. Anthony Hotel, San Antonio, Sept. 9-12.

Pacific Coast Gas Association, Annual Meeting, Coronado, Calif., Sept. 11-13.

AIEE, Electrical Conference of Petroleum Industry, Muehlebach Hotel, Kansas City, Sept. 16-19.

Mid-Continent Oil & Gas Assoc., Louisiana-Arkansas Division, Annual Membership Meeting, Roosevelt Hotel, New Orleans, Sept. 20-21.

American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference, Statler-Hilton, Dallas, Sept. 23-26.

API Executive Committee of the Board of Directors, Greenbrier Hotel, White Sulphur Springs, W. Va., Sept. 26.

International Gas Union, Sixth Annual Conference, Hotel New Yorker, New York City, Sept. 25-30.

Texas Mid-Continent Oil & Gas Association, Rice Hotel, Houston, Oct. 2-3.

Oil Progress Week, Oct. 14-20.

AGA Annual Meeting, Atlantic City, N. J., Oct. 15-17.

American Institute of Mining, Metallurgical and Petroleum Engineers, Petroleum Branch, Biltmore Hotel, Los Angeles, Oct. 15-17.

American Society of Civil Engineers, Annual Convention, William Penn Hotel, Pittsburgh, Oct. 15-19.

Rocky Mountain Oil & Gas Association, Annual Convention, Cosmopolitan Hotel, Denver, Oct. 22-24.

American Society of Safety Engineers, Annual Meeting, Conrad Hilton Hotel, Chicago, Oct. 23.

National Association of Corrosion Engineers, South Central Region, Gunter Hotel, San Antonio, Texas, Oct. 23-26.

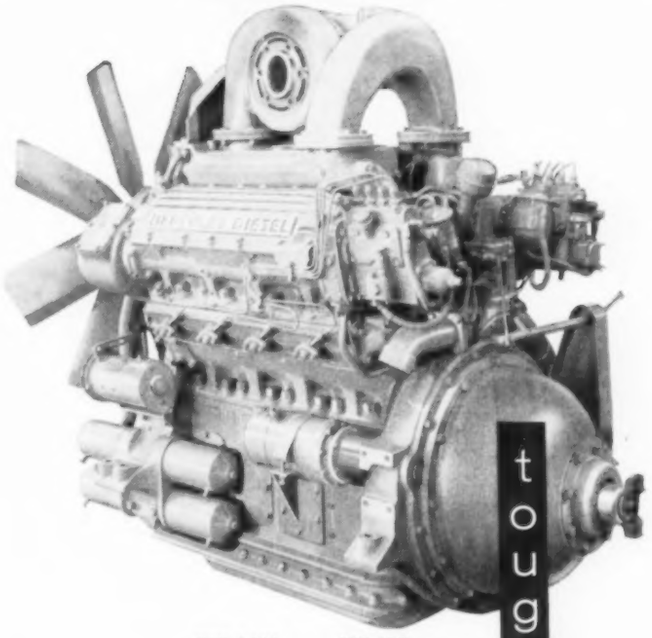
American Petroleum Institute, Annual Convention, Conrad Hilton Hotel, Chicago, Nov. 12-15.

American Society of Mechanical Engineers, Statler Hotel, New York, Nov. 25-30.

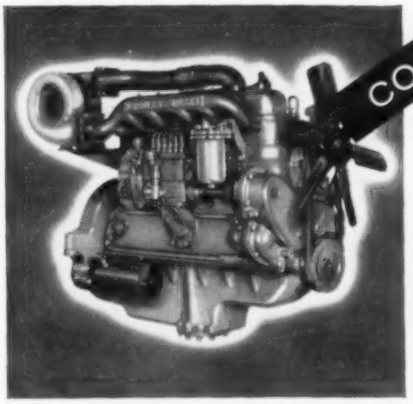
Pipe Line Contractors Association, Ninth

THREE MORE **HERCULES** ENGINES

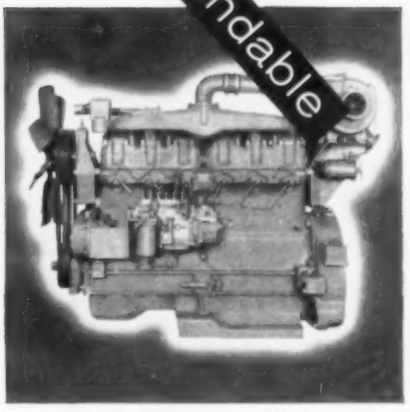
TCD's



TCD-1468 500 H.P.



TCD-501 180 H.P.



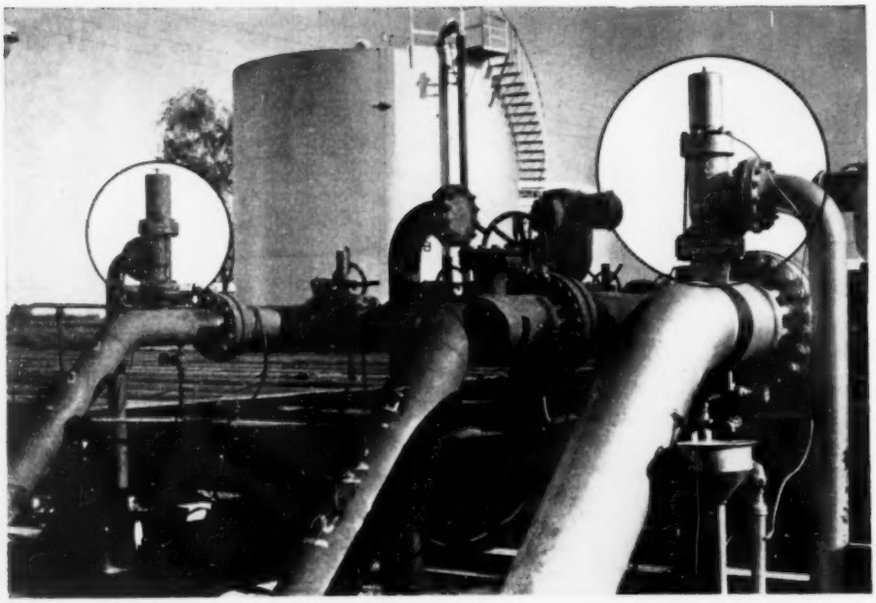
TCD-895 318 H.P.

Turbo Charged Diesel

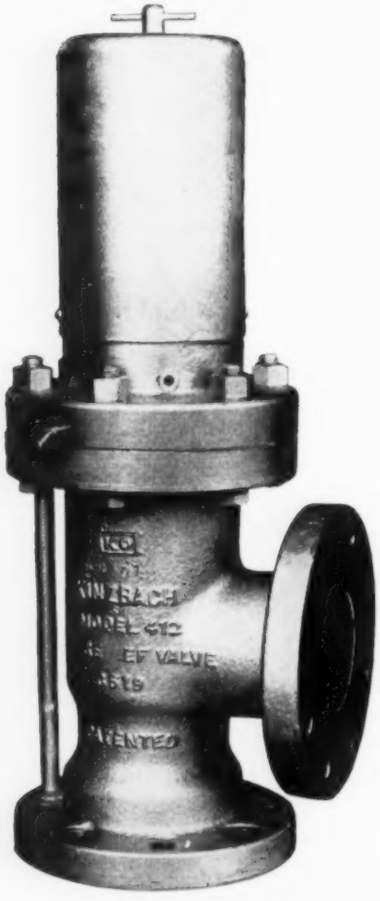
Following the Hercules policy of providing industry with the latest in engine developments, the above Hercules TCD's are available for applications requiring Tough Compact Dependable power. Complete details on these TCD's are available from the factory. Write for Bulletins D-534, D-561 and D-567.

HERCULES MOTORS CORPORATION
CANTON, OHIO

For more data on advertised products, use Readers' Service Cards, last page.



Positive Protection Against Pressure Surges



KINZBACH
MODEL 412
RELIEF VALVE
for Pipelines and Refineries

When a pressure overload in the line is reached, the Kinzbach Model 412 Relief Valve opens instantly to full capacity. This valve provides automatic resetting at a pre-determined pressure drop, positive seating and facilities for functional testing.

The Model 412 uses line pressure for opening and closing. The opening pressure is preset by application of a dead weight load. Opening and closing action is positive and reliable. The pre-set pressure never changes.

Kinzbach Model 412 Relief Valves are available in 2", 3", 4", 6" and 8" sizes for working pressures up to 1000 p.s.i. Write for Bulletin RV412 for full technical data.

KINZBACH TOOL CO INC

KINZBACH TOOL COMPANY, INC.

P. O. Box 277 Houston, Texas

Export Office: 74 Trinity Place, New York, N. Y.

Annual Convention, Boca Raton Hotel and Club, Boca Raton, Fla., Jan. 14-16, 1957.

Petroleum Equipment Suppliers Association, Palm Springs, Calif., April 6-11, 1957.

NEW BOOKS

FUEL INJECTION SYSTEMS, Brian P. Emerson, Diesel Publications, Inc., 80 Lincoln Avenue, Stamford, Conn. $2.

This is a revised edition including addition of systems introduced since the last publication in 1950 and expanded coverage of other systems.

Written for the beginner to understand, the book also includes specific service data for men in injection repair shops. Eleven injection systems in common usage are described and illustrated. Their operation is detailed and servicing data given. An extensive chapter is devoted to modern servicing techniques and the tooling used. One deals with features of special injection pumps for dual-fuel engines. Another lists nozzle test data in tabular form.

•

STANDARD FOR FIELD WELDING OF PIPE LINES, American Petroleum Institute, 50 West 50th Street, New York 20, N. Y. 50 cents.

The API has announced publication of the fourth edition of API Standard 1104 which reflects developments in pipe line welding that have taken place since the third edition was issued in 1955.

The Standard has been elevated and is no longer considered tentative. In addition to several minor changes, the fourth edition includes a section that allows multiple qualification of welders under certain circumstances.

The Standard and its latest revisions were prepared by a committee of representatives from the American Gas Association, Pipe Line Contractors Association, pipe manufacturers, American Welding Society, Society for Non-Destructive Testing and the API.

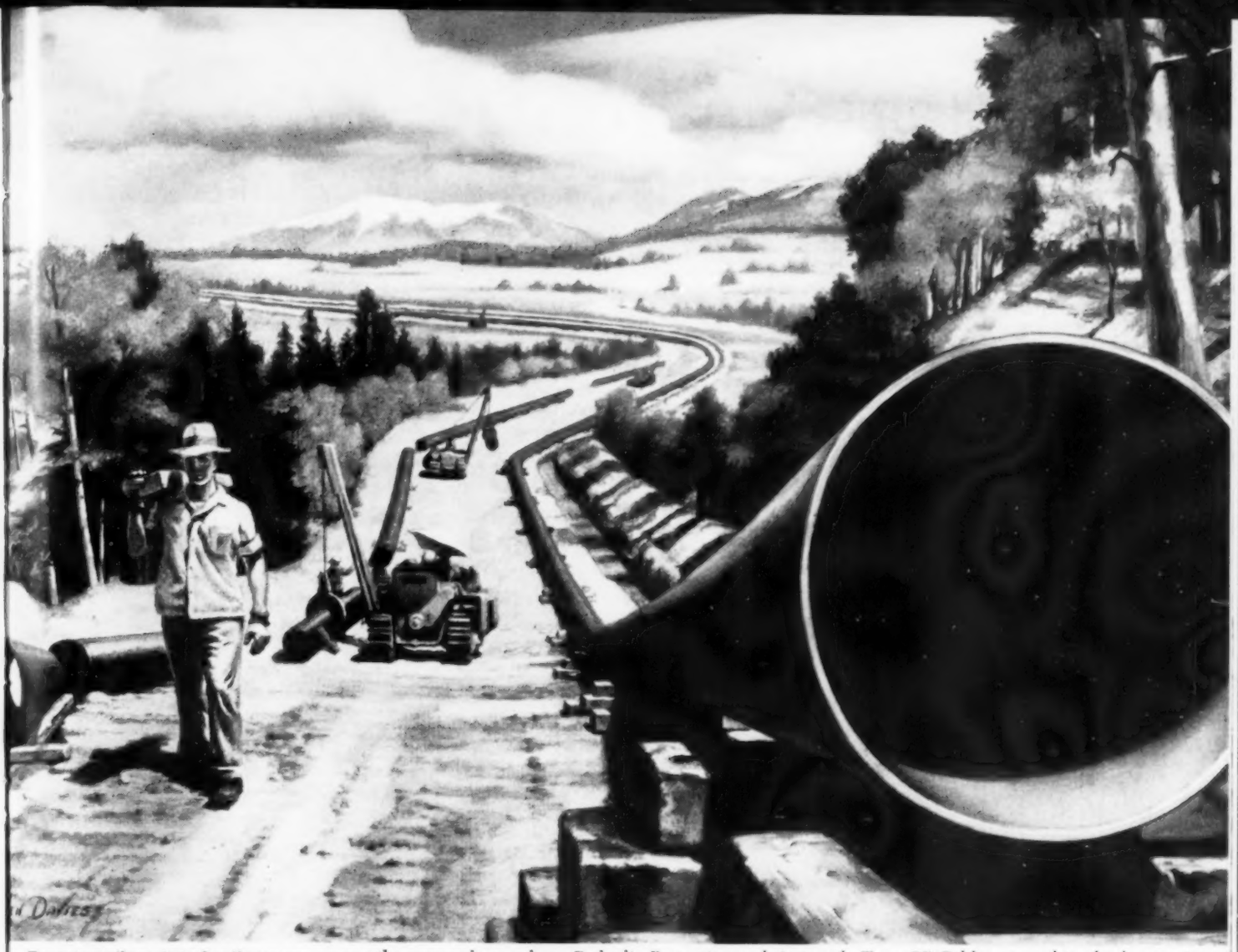
Orders may be addressed to J. A. McNally at the API address.

•

TEN YEAR INDEX TO CORROSION, 1945-54. Compiled by Norman E. Hamner and J. F. Van der Henst, Jr., National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Texas. NACE members, $5. Others, $7.50.

The alphabetical subject index consists of approximately 4000 reference phrases and alphabetical author index of 1056 names. Titles are included of 629 articles published in the first decade (1945-54) of publication of "Corrosion." The subject index, organized around the system developed for the NACE Abstract Filing Index, is intended to be of maximum service to the general corrosion worker.

The index has a variety of subject matter with data on pipe line and petroleum corrosion problems in greater volume than other topics. Numerous tables of data will be of interest to corrosion engineers.



Transcontinental pipelines are among the many places where Cathodic Protection and Anaconda Type CP Cable are used to check corrosion.

Cable that helps make the pipeline a good neighbor

To make cathodic protection systems more economical and effective – to help pipeline and oil companies check costly corrosion, stop leaks, make pipelines good neighbors – Anaconda offers a special Type CP Cable that *lasts far longer* on the job than ordinary cable.

High-grade polyethylene insulation and tough Densheath* (PVC) jacket offer high resistance to electroendosmosis†, as well as high resistance to oil, moisture, and most acids, alkalies and chemicals found in corrosive areas. And rugged Densheath withstands toughest abrasion, moisture, sunlight and weathering.

For special applications, a one-layer insulation and jacket construction of polyethylene is available.

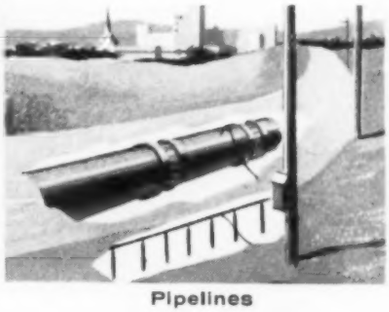
To order, or for more information—call the Man from Anaconda. Or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

*Reg. U.S. Pat. Office †Cable failure on direct current in wet locations 56557 Rev.

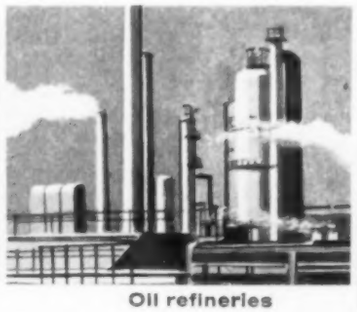
WHERE ANACONDA TYPE CP CABLE AND CATHODIC PROTECTION CUT CORROSION COSTS

Tank farms

Underground storage tanks



Pipelines



Oil refineries

ASK THE MAN FROM ANACONDA®

FOR CATHODIC PROTECTION CABLE

What's Happening

AMONG SERVICE AND SUPPLY MEN

Worthington Corporation Announces Engineering Department Promotions

Several promotions in the Worthington Corporation Engineering department, Harrison division, have been announced by the Worthington Harrison division.

E. C. Schmachtenberg, formerly assistant to the manager of engineering and chief engineer, compressors, has been named assistant to the manager of engineering. Hunt Davis, formerly chief engineer, compressor development, has been appointed chief engineer, compressors. C. A. Macaluso, previously assistant manager, research and development, has been named assistant chief engineer, compressors. W. F. Donovan, formerly group supervisor, research and development, is appointed assistant manager, research and development.

A GOOD START.. for a Long Life!

● This RUBEROID pipe line asbestos felt over PITT-CHEM hot applied tar base coating will withstand the severe corrosion attacks this pipe line may meet. The quality control to rigid specifications of these products assures years of protection for this line against moisture and electrical forces, as well as soil stress and root attack. And when you start a job, a Day man is there to give the benefit of his experience for a good start . . . part of the *plus* in the service you get when you "DEAL WITH DAY."

Both of these products are stocked in Houston for immediate delivery when you're in a hurry.

Engineering counsel, literature including specifications, and prices are furnished through our Houston office.

S. D. Day Company is National Distributor for The Ruberoid Co. pipe line asbestos felt, and Gulf Coast Distributor for Pittsburgh Coke & Chemical Co. hot and cold applied coal tar coatings, and American Coating & Supply Company "Fieldjointers."

The Pipeliner's Friend says,
"Get Formula 291 — it gives skin protection for those working where fumes may be toxic."

S. D. DAY COMPANY

3115 Buffalo Drive **Houston 19, Texas** **Phone JA 8-2431**

Carrol G. Turk Named to Post With Thew Shovel Company

Carrol G. Turk, formerly with the Martin Machine Company, Kewanee, Ill., has joined The Thew Shovel Company, Lorain, Ohio.

Carrol G. Turk

Turk's major assignment will be coordinating staff functions between the Engineering and Service departments.

Turk is a graduate engineer of the University of Missouri and had been vice president in charge of engineering and production while with the Martin Machine Company.

Kaiser Steel Plans Expansion Of Steel Mill in California

A $113 million expansion of Kaiser Steel Corporation's Fontana, Calif. steel mill has been planned. The expansion will allow a 40 percent increased production of steel ingots and finished steel.

Jack L. Ashby, vice president and general manager, announced, "This expansion will place in operation more steel producing and finishing facilities than were built into the original Fontana plant during the entire war period. It is believed this is the largest single expansion of an industrial plant in West Coast history."

Major units to be installed include an oxygen steelmaking process plant to produce steel ingots, a slabbing mill for initial rolling of the ingots, and various major changes and additions to increase output in the hot strip mill, plate mill and tin mill.

Construction is expected to be completed in about two years, although individual facilities will go into operation as they are completed.

Barrett to Expand Polyester And Phenolic Resin Production

Barrett Division, Allied Chemical & Dye Corporation, has announced plans to expand its production of Plaskon polyester and liquid phenolic resins at its Toledo plant. According to the plans, the polyester resin capacity will be more than doubled and phenolic resin capacity will be increased by four times. The new facilities are to come into operation by stages with final completion by 1957.

Midwestern Pipe Line Products Names District Sales Representative

Midwestern Pipe Line Products Company of Tulsa has announced the appointment of M. E. Maddox as district sales representative for the firm's Mid-continent area. He will have headquarters in Tulsa and will cover Nebraska, Kansas, Missouri, Arkansas, eastern Oklahoma, Fort Worth and Dallas.

Before joining Midwestern, Maddox was associated with Pipelife Corporation as sales manager.

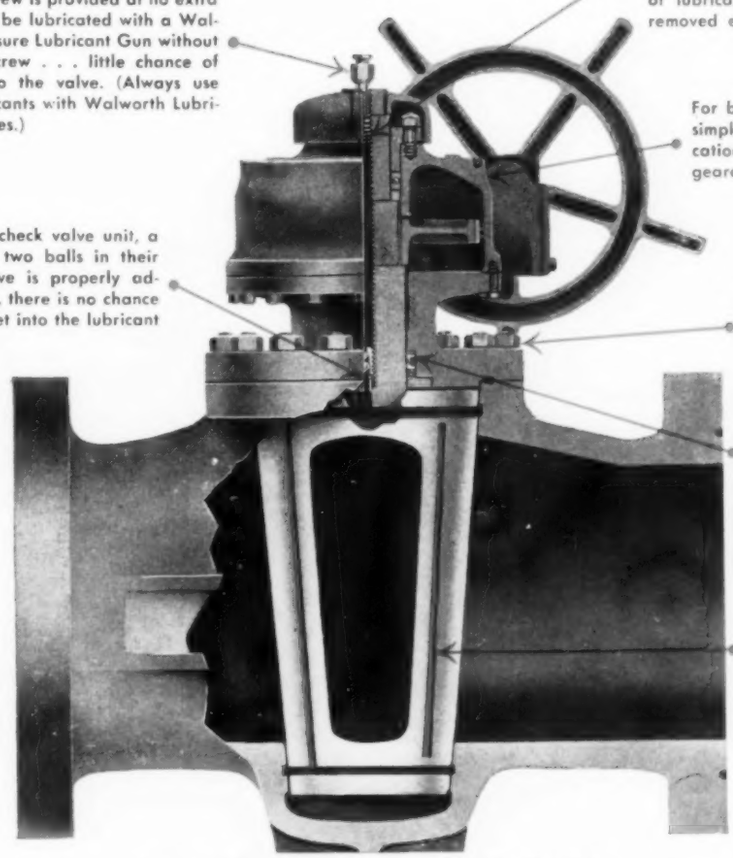
Let's get technical about WALWORTH LUBRICATED PLUG VALVES for pipeline service

Combination button-head lubricant fitting and lubricant screw is provided at no extra cost. Valves can be lubricated with a Walworth High Pressure Lubricant Gun without removing the screw . . . little chance of grit getting into the valve. (Always use Walworth Lubricants with Walworth Lubricated Plug Valves.)

An added safety feature in the form of a groove cut part way up side of the lubricant-fitting screw allows the operator to observe any tendency of lubricant to blow out before the screw is removed entirely.

For buried pipelines — yoke design permits simple attachment of handwheel and lubrication extensions without modifying the gearcase.

In the stainless steel check valve unit, a transverse pin holds two balls in their seats. When the valve is properly adjusted and lubricated, there is no chance for line pressure to get into the lubricant system.



Standard bolt threads, rather than fine threads, mean easy replacement of nuts and bolts from local stocks.

Two overlapping Teflon packing rings form an effective seal against possible leakage without "grabbing" the plug shank. Low breakout torque . . . plug turns easier. Packing serves only as a seal and is not used to hold the plug in its seat.

Lubricant grooves completely frame the port openings and encircle the plug at the top and bottom assuring a tight seal against leaks. Bottom circumferential groove is separate from, but connected with, the lubricant well.

Other Walworth Lubricated Plug Valves include Single Gland and Regular Gland types. Sizes to 30 inches. Pressures to 5000 psi. and for vacuum service.

Cutaway of a 24-inch Walworth Lubricated Plug Valve

Without exception, a Walworth Ball Bearing Lubricated Plug Valve is easier to operate and maintain than any other type of rotary-action, sealed valve available today for pipeline service. Design features pointed out here show just a few advantages of Walworth Ball Bearing Lubricated Plug Valves.

Many pipeline companies throughout the world use Walworth valves for handling gas, crude, and finished products. Investigate the line of Walworth valves for your own needs. See your Walworth Distributor, or write for literature: Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.

Use pigs or scrapers?

Walworth Type 49 Cast Steel Gate Valves are designed on the throughport principle to permit passage of pigs and scrapers — may be installed without regard to flow direction. Sizes 2 to 30 inches inclusive. Ask for literature.

WALWORTH

Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Paul D. Nerren

William A. Gormley

Bart R. Braznell

M. J. Conley

W-K-M Manufacturing Appoints Four Department Sales Managers

Sales managers of four departments of W-K-M Manufacturing Company, Inc. have been announced recently in Houston.

Paul D. Nerren is sales manager of the Pipe Line Valve department; William A. Gormley is sales manager of the ACF Lubricated Plug Valve department; Bart R. Braznell, sales manager of the KEY Products department; and M. J. (Bud) Conley, sales manager of the Drilling and Production Valve department.

Nerren started with W-K-M on the valve assembly line in 1934, was promoted to sales and service in 1947 and now becomes sales manager of the Pipe Line Valve phase of W-K-M operations. Gormley was with the former ACF Valve division, Detroit, for 20 years, serving as sales manager for 19 years. With the former Key Company of East St. Louis for 26 years, Braznell started as a draftsman, was made chief engineer and in 1955 became sales manager. Conley started in the oil business 35 years ago as a roughneck. He has been with W-K-M for ten years as sales representative in the Gulf Coast area.

Coke Is Assistant District Engineer For Oil Well Supply Division

Otha V. Coke has been named assistant district engineer, machinery and equipment sales at Liberal, Kansas, for U. S. Steel's Oil Well Supply Division.

Coke was employed by Oilwell in 1951 in Oklahoma City. He became field representative the following year and moved up to assistant district engineer, machinery and equipment sales. Coke was appointed district representative and transferred to El Dorado, Kansas, before his recent assignment.

General Electric to Build New Plant in Lynchburg, Va.

Contract has been awarded to the George A. Fuller Company of New York, associated with John P. Pettyjohn and Company of Lynchburg, Va., for construction of a new plant in Lynchburg to house the General Electric Company's Rectifier department. The plant is expected to be completed by spring of 1957.

The Lynchburg plant with more than 250,000 square feet of office, manufacturing and laboratory space, will employ about 1000 persons. It will occupy a 100-acre site two miles beyond the Lynchburg city line.

Atlas Powder Fills 3 Posts In Explosives Department

Atlas Powder Company has appointed three men to new posts in the Explosives department. Albert W. Strahorn, formerly assistant chief engineer, becomes director of explosives production; Henry T. Clark, formerly head of the chemical control section, has been named planning assistant to the vice president, D. J. C. Copps. Succeeding Clark will be Lewis T. Marks, Jr., formerly superintendent of the dynamite division at the company's Reynolds Works, near Tamaqua, Penn.

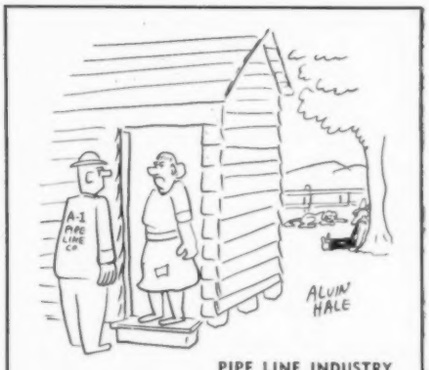
There's a sense of security when a Sheehan "spread" is tending the job . . . an assurance that only the most efficient in equipment, methods and manpower is being used to complete your project *on time.*

Your project, whether large or small, will receive our immediate and reliable attention.

SHEEHAN PIPE LINE CONSTRUCTION CO. TULSA OKLA

SHEEHAN

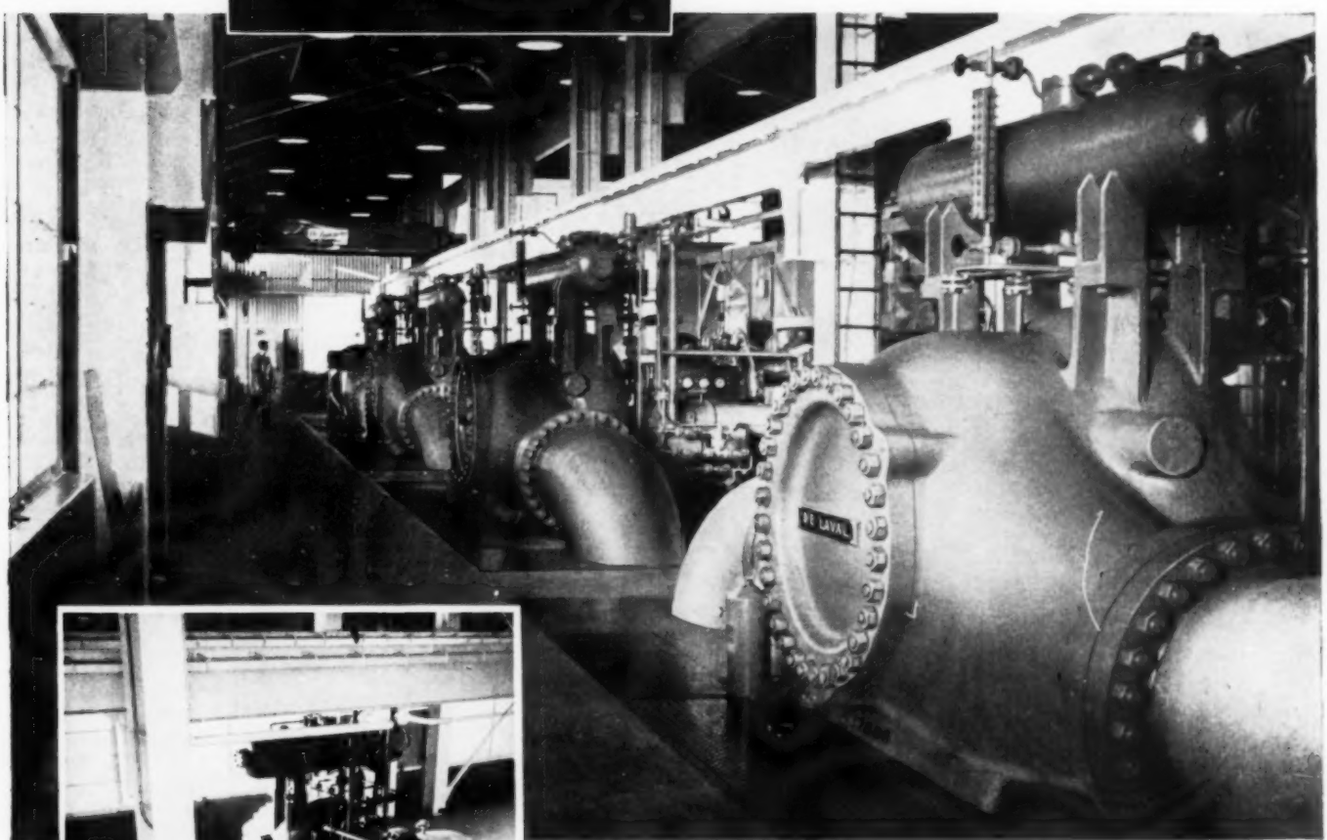
Natl. Bank of Tulsa Bldg. • Tulsa, Oklahoma

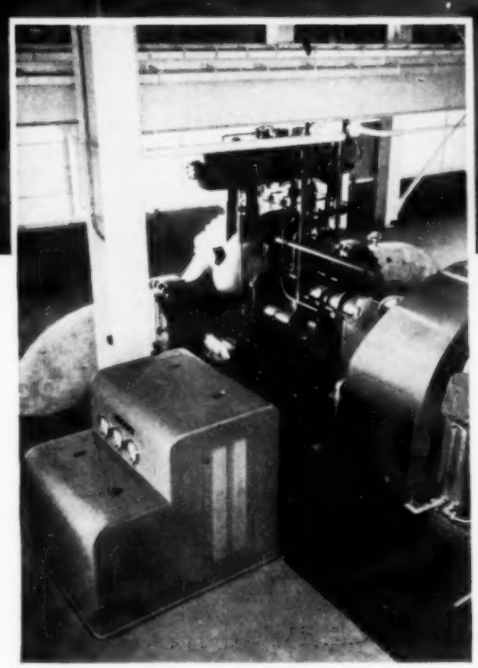


PIPE LINE INDUSTRY

"It's O.K. to put your pipe line through if you don't disturb the dog and Grandpaw."

FOUR **DE LAVAL CENTRIFUGAL COMPRESSORS** *in Tescott, Kansas station of Northern Natural Gas*





For easy installation, De Laval pipeline compressors are designed in two packages: (1) The machine plus the emergency seal tank, (2) The auxiliary console which contains the filters, pumps, coolers and other accessories.

Here's more proof of the efficiency and dependability of De Laval centrifugal compressors for high pressure gas transmission. This Tescott, Kansas station of the Northern Natural Gas Co. has four De Laval centrifugal compressors in series.

The station flow is 930 M²SCFD, station inlet pressure 477 psig and discharge pressure 745 psig. *By changing the impeller and a few minor parts, these units can handle 1,100 to 1,200 M²SCFD.* Three identical De Laval compressors are on the job in the Macksville, Kansas station of Northern Natural.

De Laval centrifugal compressors offer important engineering features. • Pressure contact shaft seal eliminates gas leakage. • Construction is heavy and rigid throughout. • Units have high load carrying capacity. De Laval units, totaling more than 280,000 hp, are now in operation on major pipelines.

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY
884 Nottingham Way, Trenton 2, New Jersey

DL309

For more data on advertised products, use Readers' Service Cards, last page.

BrakeSol Treating Engineers Meet

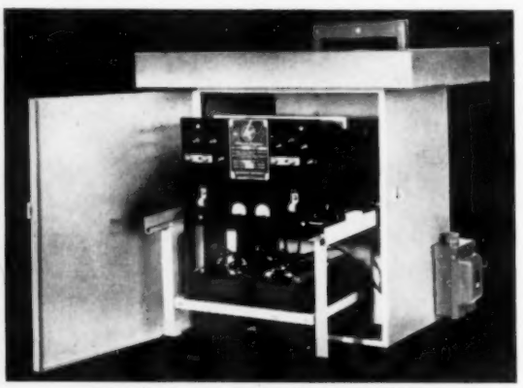
Attending a recent three-day conference of BrakeSol, Inc. in Oklahoma City were the following BrakeSol treating engineers, front row, left to right: George Lynch, Ft. Morgan, Colo.; Ralph Urso, Detroit, Mich.; Bill Ramsey, Carmi, Ill.; Lester P. Brake, Oklahoma City; Cecil C. Blackwell, Houston; Jeff Villines, Ardmore, Okla., and "Frenchy" Howard, Lovington, N. M. Back row, left to right, "Pat" Curtin, Oklahoma City; Kahle Wilson, Oklahoma City; J. W. Page, Odessa, Texas; Jim Rea, Ellinwood, Kansas; Buford Cranford, Oklahoma City; Harvey H. Lowe, Oklahoma City; "Al" Grimsley, New Iberia, La.; and Bill Barton, Casper, Wyo.

EXTRA *DEPENDABILITY*

FOR ANY CATHODIC PROTECTION PROGRAM

HOLCOMBE SELENIUM RECTIFIERS

Small size steel cabinet rectifier.



Medium size steel cabinet rectifier.

Backed by fourteen years' experience in corrosion prevention, Holcombe rectifiers are soundly designed, ruggedly built, and carry an exceptionally long term warranty. That's why you'll find them all over the country, in use by major oil, pipeline and industrial firms. No matter what your rectifier application may be, there's just the right Holcombe unit to fit the job. Available in all sizes, they are made with cabinets of cadmium plated steel or aluminum. *Write for new literature on Holcombe rectifiers and other corrosion products.*

THE HOLCOMBE COMPANY, INC.

FIRST NATIONAL BANK BUILDING TELEPHONE 5-3468
SHREVEPORT, LOUISIANA

RECTIFIER DIVISION 617 MONTGOMERY ST. TEL. 4-1477

HOLCOMBE COMPANY OF CANADA, INC.

323 BARKER BUILDING TELEPHONE 6-7291
CALGARY, ALBERTA, CANADA

Lion Coatings • Holcombe Selenium Rectifiers
Pipe Wrappings • Graphite Anodes • Coke Breeze

Lacombe to be Manager-Sales For National Tube in New Orleans

E. J. Lacombe has been appointed manager of sales of the New Orleans sales office of National Tube Division, United States Steel Corporation. Formerly assistant manager of sales, Lacombe succeeds T. W. Thorne, who has retired.

Lacombe joined U. S. Steel Corporation in 1927. In 1951 he was transferred to the division's main office in Pittsburgh, where he served until 1954 in an administrative capacity in the Sales department before being transferred back to New Orleans.

Youngstown Sheet and Tube Names District Sales Managers

R. P. Broadhurst and C. Hix Jones have recently been named to district sales manager posts for The Youngstown Sheet and Tube Company.

Broadhurst's position is in the Chicago district and Jones in the Dallas district. Jones succeeds Frank D. Carroll, who is retiring after approximately 40 years service with the company.

M. Mark Watkins Elected To Walworth Company Board

M. Mark Watkins was elected to the board of directors of the Walworth Company recently. Watkins is executive vice president and director, Conoflow Corporation. Conoflow recently merged with Walworth. Watkins also is vice president and director of the Remington Corporation.

M. Mark Watkins

Before his association with Conoflow in 1943, Watkins was with People Bond and Mortgage Company, Carrier International Division and Brown Instrument division of Minneapolis-Honeywell Regulator Company.

Johnston, Love, Miller Named To Oil Well Supply Positions

U. S. Steel's Oil Well Supply division has announced transfers and appointments of Roy A. Johnston, Jr., James T. Love, and Gerald E. Miller.

Johnston, field representative, has been transferred from El Dorado, Ark. to Shreveport, La. Love is appointed district representative at New Orleans and Miller was named store manager of the El Dorado, Kansas, store.

Chilcoat New Fisher Governor Representative in Pittsburgh

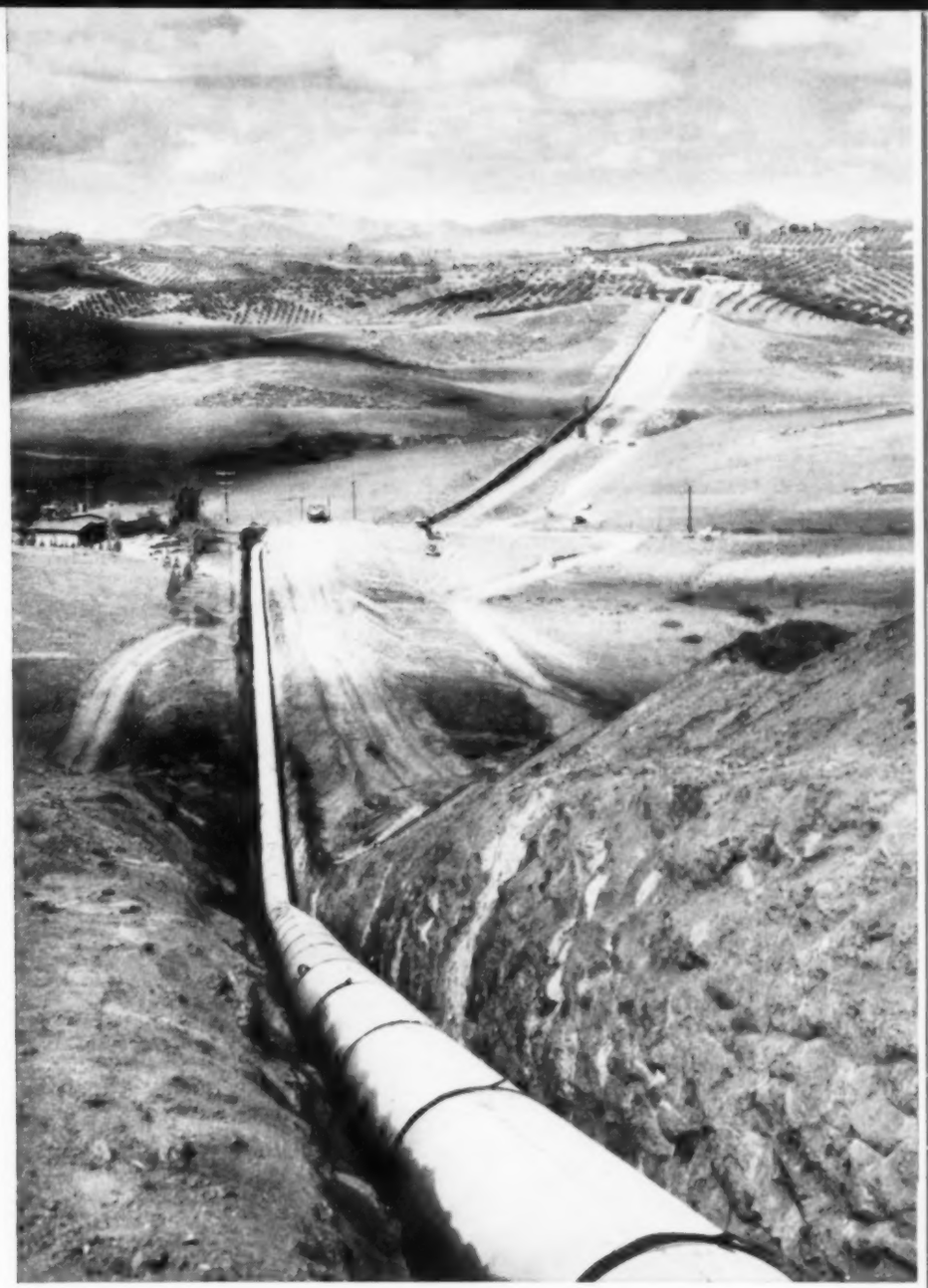
Fisher Governor Company has announced the appointment of J. G. Chilcoat and Company of Pittsburgh as exclusive sales representative for western Pennsylvania and West Virginia.

The new sales office is headed by Jess G. Chilcoat, who has been associated with Fisher Governor Company both in field offices and at the Marshalltown plant more than ten years.

S. W. Prince, R. G. Read and Bob Neville, all formerly with the W. A. Stoeltzing Company, Pittsburgh, will be associated with Chilcoat as sales engineers.

ACROSS HILLS AND VALLEYS

Explosives Research Pays Off



Blasting trenches in hard granite formations to install a pipeline in Southern California called for engineering skill, operating know-how, and a knowledge of explosives.

Over hills and valleys and across rivers and gorges, pipelines provide safe, sure, economical means of transportation for petroleum, natural gas, water, and other mineral resources. When rock is encountered, blasting crews with specialized explosives take over. Here is where explosives research pays off.

Continuous research and extensive knowledge of field conditions have been Hercules' business for more than forty years. Hercules technical representatives welcome opportunities to discuss problems and help in the selection of the right explosives and the most efficient methods for use in mining, quarrying, construction, and exploration projects.

HERCULES

HERCULES POWDER COMPANY

INCORPORATED

Explosives Department, 939 Market Street, Wilmington 99, Delaware

Birmingham, Ala.; Chicago, Ill.; Duluth, Minn.; Hazelton, Pa.; Joplin, Mo.; Los Angeles, Calif.; New York, N. Y.; Pittsburgh, Pa.; Salt Lake City, Utah; San Francisco, Calif.

XR55-3

See Composite and Refinery Catalogs, or Write for Specifications Folder

FLEET-LINE

PIPE SADDLES AND REDUCERS

Nozzle sizes from ¼" to 24"

ASTM A234

Also for pressure vessel heads

Nominal pipe sizes 1" to 30"

Special sizes and lengths. Schedules 10 to 160 Stainless Steel, and other Alloys.

ASA B16.9
ASTM A234

Immediate Delivery

STEEL FORGINGS, Inc.

P. O. Box 276K • Shreveport, La.

Foot of Fannin Street

NEW! Write for Bulletin.

Patented

PIPELINE VENTS AND MARKERS

FLEET-LINE CO.

P. O. BOX 276K

SHREVEPORT, LOUISIANA

F. W. Birmingham

C. A. Nicklas

Jones & Laughlin Establishes Sales Office in Pittsburgh

Jones & Laughlin Supply division has announced the recent establishment of a separate sales office in Pittsburgh, Penn. and Frank W. Birmingham, formerly a salesman serving the Pittsburgh area, has been appointed sales office manager in charge of major accounts in Pittsburgh and Charleston.

C. A. Nicklas has been named district sales manager and will assume the full responsibility of the field sales organization within the district, including J&L oil field supply stores located in Bolivar, N. Y., Bradford, Penn.; Canton, Ohio; Clarion, Penn.; Clarksburg, W. Va.; and Paintsville, Ky. Nicklas, formerly assistant district sales manager since January 1, 1955, succeeds H. E. Wagner.

Voorhees Retires as Chairman Of Finance of U. S. Steel

Enders M. Voorhees, chairman of the finance committee of United States Steel Corporation, has retired and Robert C. Tyson has been elected to fill the vacancy.

Voorhees will continue as a director, member of the Finance Committee and consultant. Tyson has been with U. S. Steel since 1939 in various capacities, the most recent as comptroller and vice chairman of the Finance Committee.

New Tractor Plant Dedicated By Caterpillar in Illinois

The world's largest motor grader and wheel-type tractor plant was dedicated in Decatur, Ill. in May by Caterpillar Tractor Company.

Built to accommodate the company's increased production of wheel-type tractors and motor graders and release facilities at Peoria for added output of crawler tractors and diesel engines, the new plant is located on a 425-acre plot near Decatur.

The manufacturing building is of aluminum painted corrugated steel sheathing. Two assembly lines extend nearly the entire length of the plant. Adjoining the front half of this building is a two-story brick administration building which houses the plant offices, medical section and an auditorium. The two main buildings provide more than 840,000 square feet of manufacturing and office space.

STOP THOSE CORROSION LEAKS ON BURIED OIL, GAS AND WATER LINES WITH "CORECO" RECTIFYING SYSTEMS

Experienced "CORECO" engineers, specialists in design and installation of rectifier and galvanic anode cathodic protection systems, are ready to analyze and solve your corrosion problems.

WHEN YOU THINK OF CORROSION, CALL

Coreco

FOR COMPLETE CATHODIC PROTECTION

A Complete Design and Installation Service. Call, wire or write today to

CORROSION RECTIFYING COMPANY

1506 Zora Street • Houston, Texas

NOTICE: Specify PELCO Welding Saddles

No change except the corporate name. We still have the same ownership, same management, same address, same telephone, and use the same 45 years of experience to render the same service under the same trade name—"PELCO."

PELICAN SUPPLY CO. INC.

P. O. Drawer 1108 Shreveport (84), La.

SEE YOUR NEAREST SUPPLY HOUSE

GUNITE COATINGS for PIPE LINES

Reinforced GUNITE COATING being applied to pipe.

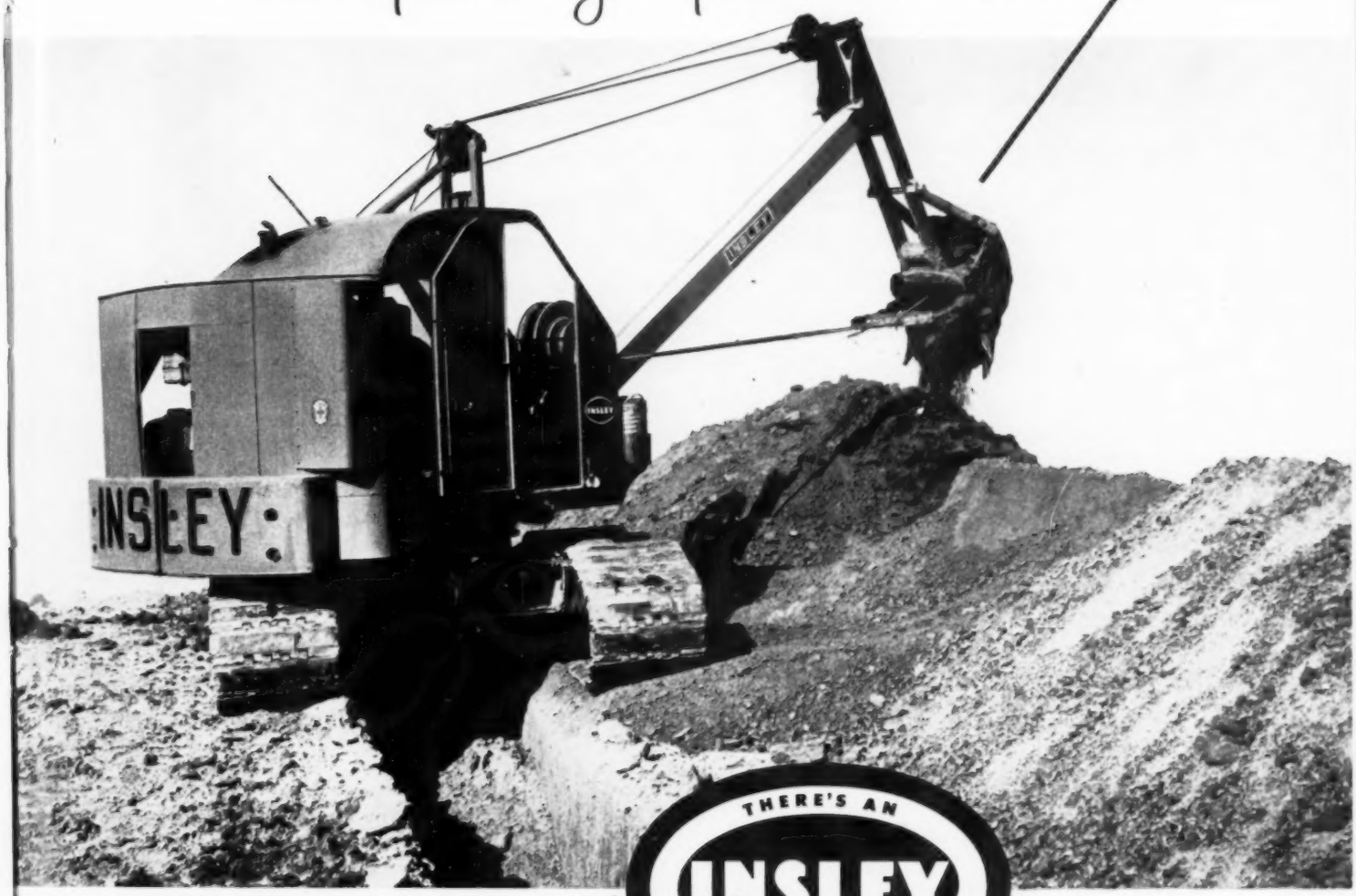
Your inquiry solicited.

GUNITE CONCRETE & CONST. CO.

1301 WOODSWETHER RD., KANSAS CITY 5, MO.
3206 HOUSTON, HOUSTON 9, TEX.
CHICAGO – ST. LOUIS – DENVER
MILWAUKEE & TWIN CITIES – NEW ORLEANS

the INSLEY "pipeliner"

...as requested by Pipeline Contractors



THERE'S AN **INSLEY** WORKING NEAR YOU

The Insley "Pipeliner" is the hard-working answer to the contractor's need for a machine especially designed for pipeline work . . . a machine with "built-in" durability and stamina that will withstand the severe operating conditions of cross-country pipelining.

- **New, wide, deep carbody with removable bottom cover plates**
- **Crawler rollers and tumblers sealed against dirt**
- **Two-speed travel (optional) through two-speed transmission .8 M.P.H. and 1.6 M.P.H.**
- **Increased stability and flotation with 12'-6" crawlers and 24" or 30" shoes**
- **Long wearing, heat-treated, alloy steel crawler shoes and pins**

The "Pipeliner" is fully convertible for hoe, shovel, dragline, clamshell and crane work, and is available with gasoline or diesel power. See your Insley distributor for full details or write direct to Insley.

INSLEY MANUFACTURING CORP. • INDIANAPOLIS, IND.

Wholly owned subsidiary / THE MAXI CORP. • LOS ANGELES

IT'S NEARING COMPLETION...
PACIFIC NORTHWEST PIPELINE'S
"SCENIC INCH"

Winding across New Mexico's deserts, climbing the snow-capped Colorado Rockies and ending at last in the evergreen country of Oregon and Washington . . . Pacific Northwest Pipeline Corporation's 2300-mile "Scenic Inch" is being rushed to completion.

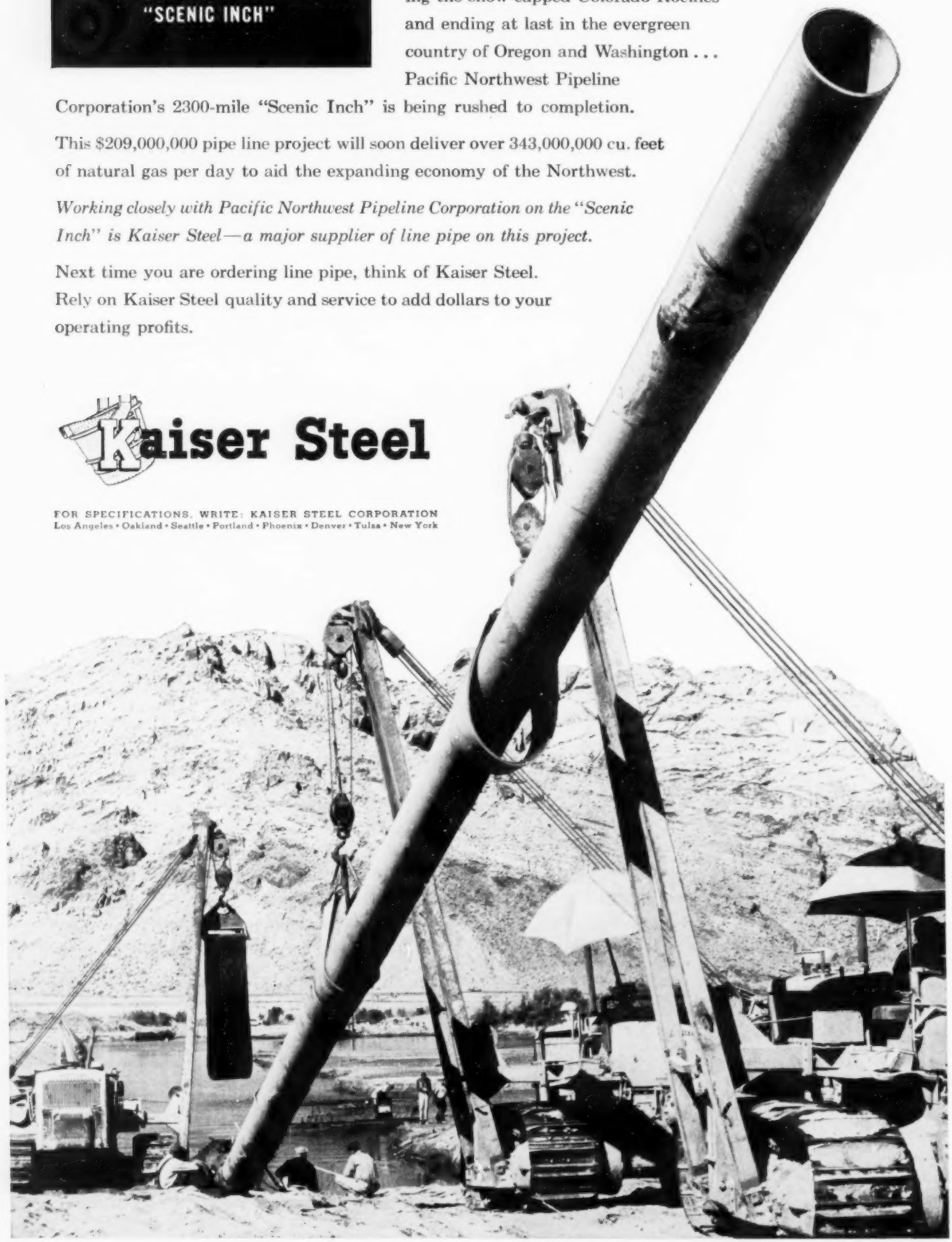
This $209,000,000 pipe line project will soon deliver over 343,000,000 cu. feet of natural gas per day to aid the expanding economy of the Northwest.

Working closely with Pacific Northwest Pipeline Corporation on the "Scenic Inch" is Kaiser Steel—a major supplier of line pipe on this project.

Next time you are ordering line pipe, think of Kaiser Steel. Rely on Kaiser Steel quality and service to add dollars to your operating profits.

Kaiser Steel

FOR SPECIFICATIONS, WRITE: KAISER STEEL CORPORATION
Los Angeles • Oakland • Seattle • Portland • Phoenix • Denver • Tulsa • New York



Assembled for Sumatra Trip

One of 19 Aldrich 6-inch Triplex direct flow pumps is shown being assembled for shipment to Standard Vacuum Oil Company. These units will be installed on Stanvac's Central Sumatra pipe line for handling 105° F. pourpoint crude between the Lirik field and the Buatan terminal on the Siak River. From there the crude will be shipped by tanker to the company's refinery near Palembang in South Sumatra.

Rockwell Names Daugherty Assistant to President

A. Clark Daugherty

A. Clark Daugherty, former market research manager of Rockwell Manufacturing Company, has been named assistant to the president. The market research, public relations and stockholder information departments will continue to report to Daugherty, who also has been assigned additional management functions.

Daugherty joined Rockwell in 1946 and was named manager of market research in 1951. In 1953 he received additional responsibilities of manager of public relations.

Three Personnel Appointments Announced by Alco Products

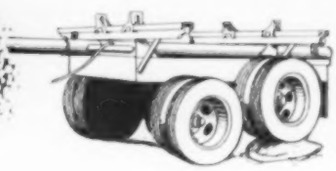
ALCO Products, Inc. has announced three new assignments in the personnel department at its Dunkirk, N. Y. plant.

Under the reorganization, Henry Gdula will be plant personnel manager, Robert Webster will assume community relations responsibilities, and Kenneth C. Brimmer will be supervisor of employment and placement practices.

Gdula, a native of Buffalo, joined ALCO in 1948 and had been supervisor of employment and job evaluation at the Dunkirk plant since 1954.

Webster had been supervisor of compensation for ALCO since 1953, when he joined the company after working for five years as a claims adjuster for Liberty Mutual Insurance Company. Brimmer joined ALCO in 1941 and was senior payroll clerk prior to receiving his new assignment.

CROSS COUNTRY



IN STRIDE

SPENCER-SAFFORD LOADCRAFT PIPELINE TRAILERS

Here is your top-quality pipeline trailer that's really built for cross-country...on or off the highway. Double-pivot tandem for axle equalization and longer tire life. Exclusive hi-tensile, pressed-steel frame permits greater payload. Carrying on the Spencer tradition of quality, the Pipeliner combines lightweight with extreme ruggedness at a moderate price.

Choose among Spencer Oil Field Floats, Pole trailers, low beds. Available in tandem or single axle.

Spencer-Safford LOADCRAFT
AUGUSTA, KANSAS

Please send me information on your
Pipeliner___ Pole Trailer___ Oil Field Float___

NAME .....
ADDRESS .....
TOWN ..... STATE .....

LEADERS IN QUALITY

Gotkool
WATER CANS and COOLERS

"GOTKOOLS" are built on the exclusive Gott principle of double wall thermo type construction, making it possible to keep water cool for long periods of time. They're made with snug-fitting, large removable tops, handy, non-leaking, push-button faucets, and convenient handles. *Buy* **"GOTKOOL"** *from your favorite supplier today.*

GOTKOOL Water Can — made in 1½, 2, 3, 5, 10, 15, and 20-gallon sizes without faucets. Extended or recessed flush-mounted faucets available at slight additional cost. *(Note: 15- and 20-gallon sizes available with extended faucet only.)*

GOTKOOL Water Cooler — made in 2, 3, 5, 8, 10, 15, and 20-gallon sizes with extended or recessed flush-mounted faucet optional. *(Note: 15- and 20-gallon sizes available with extended faucet only.)*

KEEP PURE DRINKING WATER ALWAYS HANDY

H. P. GOTT MANUFACTURING COMPANY
WINFIELD, KANSAS

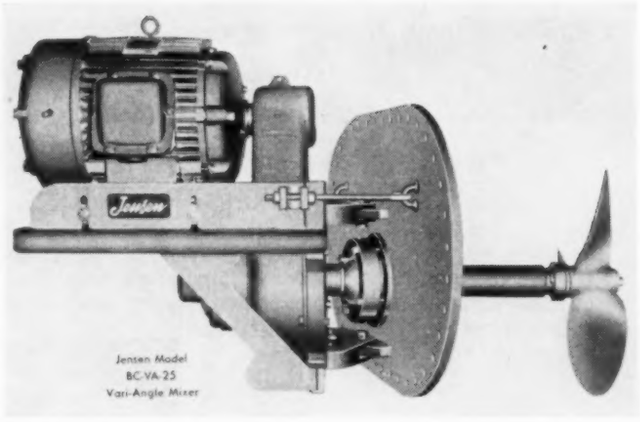
Use Readers' Service Postcards For More Information on Advertised Products

What's New in Equipment

for the Pipe Line Industry

Vari-Angle Mixer

Tank Service, Inc. has been appointed national distributor by Jensen Engineering Co. as national distributor to the pipe line industry for the new Jensen Vari-Angle mixer.



Jensen Model BC-VA-25 Vari-Angle Mixer

This newly-developed mixer was designed principally for use on crude oil tanks to prevent deposits of sediment on tank bottoms. The Vari-Angle mixer produces a direct flow stream by varying the angle of the stream, during operation, by changing the angle of the mixer. The angle of adjustment is 15 degrees to either side

A ball type stuffing box between the mixer shaft housing and manway cover provides a seal whereby the angularity may be changed with the mixer running. Locking type adjustment screws on each side provide settings at any angle. The angle of adjustment is indicated on a easy-to-read scale.

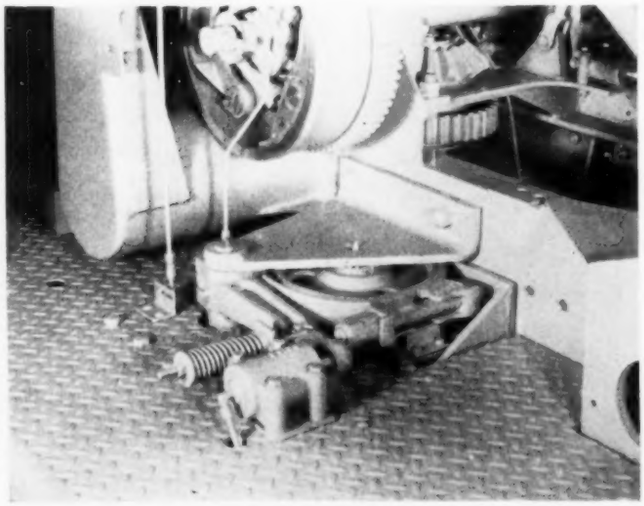
Heavy pins support the mixer from the cover. Mounting is usually made in the bottom portion of the cover to allow extra space for floating roofs.

Jensen mixers are available in all standard mixer horsepower ratings and are mounted on one-inch thick covers to fit the various manway types and sizes. Installation is made by bolting the mixer and cover to the manway and by connecting power through a flexible conduit to permit the angular movement from side to side. No assembly or welding is required.

For more data circle **No. E1** on Readers' Service Card, last page this issue.

Swing Brake

Link-Belt Speeder Corporation has announced the availability of a friction type swing brake on all shovel-cranes. The complete Link-Belt Speeder line of crawler and rubber-tired shovel cranes in one-half to three-yard digging capacities and 12½ to 35-ton lifting capacities now has available the hydraulic control swing brake feature.

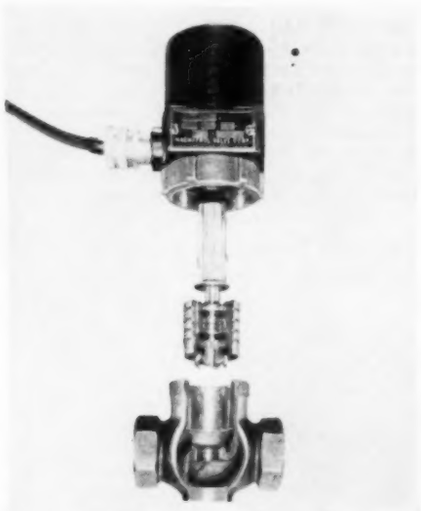


Useful in lifting crane operations requiring precision spotting of loads, the hydraulic control swing brake allows an operator to hold the boom of all Link-Belt Speeder shovel-cranes in any desired position by fingertip control. Braking effort is hydraulically applied through "Speed-o-Matic" power hydraulic controls and spring released.

One feature is the application of the able pressure hydraulic valve. The company amount of drag required to reduce bination allows the operator to provide drifting of the boom in high winds or on an incline, or to set the brake fully and still have both hands and feet free to operate other levers.

This item supplements Link-Belt Speeder Corporation, Division of Link-Belt Company data on page 2996 of the Composite Catalog, 21st Edition.)

For more data circle **No. E2** on Readers' Service Card, last page this issue.



Magnatrol Valves

Precision Magnatrol solenoid valves manufactured by The Magnatrol Valve Corporation feature a removable operating assembly to facilitate inspection and cleaning or complete replacement of operating parts without disturbing the electrical connection (if flexible conduit is used), and while the valve body remains in the pipe line.

Quick access to the interior of the valve enables the operator to clean and reassemble the valve with a minimum of shut-down time. Disassembly of valve may be completed in three simple steps. After the bonnet ring has been decoupled, the hermetically sealed solenoid cup with attached flexible power feed line is removed from the valve body. Last, the complete interior valve mechanism is taken out as a unit. The valve body remains in the line, ready for inspection or cleaning.

In many solenoid valve applications, the duty cycle will run to six and seven figures. In the event service of the valve is indicated, a complete interior valve unit is available for quick, complete replacement of the operating mechanism.

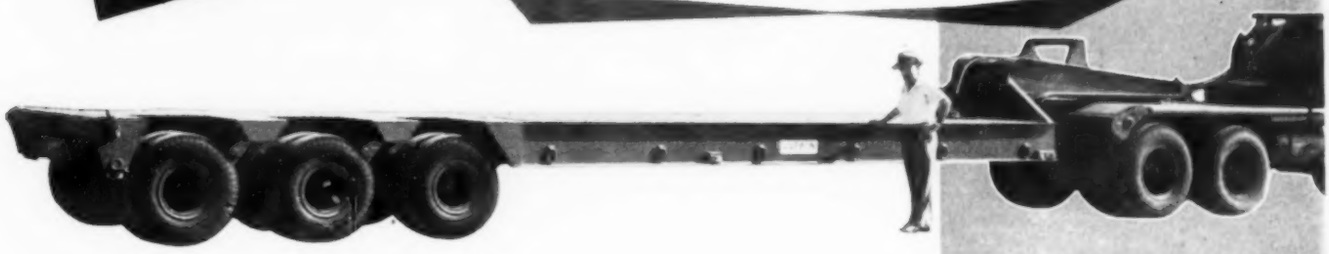
For more data circle **No. E3** on Readers' Service Card, last page this issue.

LUFKIN TRAILERS

The job is well on its way when you choose a

LUFKIN Low-bed

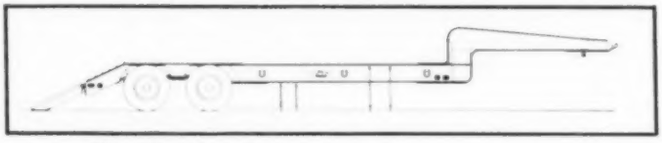
for your many hauling problems



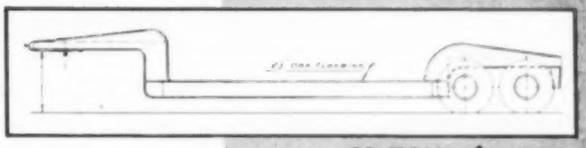
LUFKIN "CUSTOM BUILT" LOW-BED TRAILERS OFFERED IN ALL SIZES FROM SMALL SINGLE AXLE LOADS TO THE HEAVIEST 3 AXLE RIG AVAILABLE.

LET YOUR NEAREST **LUFKIN MAN** EXPLAIN HOW YOU CAN SAVE ON HEAVY MACHINERY HAULS WITH A

Low Boy By LUFKIN

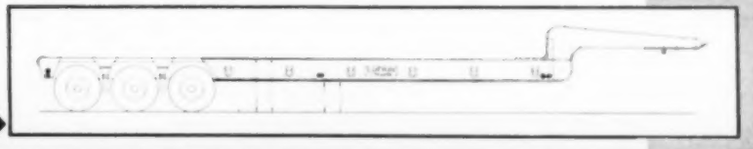


▲ 25 TON TANDEM AXLE (STRAIGHT DECK–REAR LOADER)



25 TON ▲ TANDEM AXLE (LOW DECK–SIDE LOADER)

50 TON–3 AXLE ▶



LUFKIN TRAILERS

DIVISION OF **LUFKIN FOUNDRY & MACHINE CO.**

FACTORY: LUFKIN, TEXAS • Phone 3-4425

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For more data on advertised products, use Readers' Service Cards, last page.

REPAIR LEAKS
QUICKLY—PERMANENTLY

SKINNER-SEAL PIPE JOINT CLAMPS stop leaks at joints. Put on under pressure—without interruption of service. Quick, simple, lasting repair. Sizes 1/2" to 24" incl. in stock.

SKINNER-SEAL COLLAR LEAK CLAMP—designed to stop every type of collar leak in oil and gas lines. Sizes: 2" to 13" inclusive.

M. B. SKINNER COMPANY
SOUTH BEND 21, INDIANA, U. S. A.

BrakeSol

ELIMINATES COSTLY PARAFFIN REMOVAL METHODS

HOLDS PARAFFIN IN SUSPENSION
from FORMATION to REFINERY

BRAKESOL is economical and safe to use, prevents and removes paraffin from the tubing, flow lines, tank bottoms and pipe lines. Effective on both asphalt and mixed-base paraffin.

FOR SERVICE CONTACT YOUR NEAREST BRAKESOL SALES ENGINEER

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BRAKESOL, Inc.
P.O. Box 9506 Okla. City, Okla.

Brush Cutter

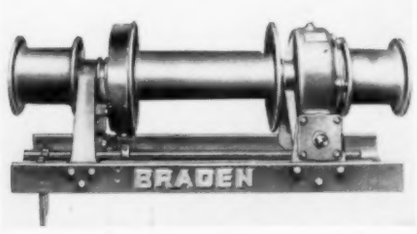
Southworth Machine Company's senior model brush cutter is useful in irrigation and swamp clearance because it operates under water. It cuts grass, weeds, brush and trees up to ten inches in diameter. This cutter is said to do the work of eight men using brush hooks or scythes.

The 2.8-horsepower patented machine fits on the operator's back, leaving both hands free for cutting operations and clearing. Because of its scientific construction and mounting, there is no vibration and greater production with less effort and fatigue is possible.

Other features of this cutter are the saw arm elbow, knee joint and "offset" cutting end. These permit the operator to tilt the saw up, down and sideways in any direction, making possible the coverage of a greater area from one position.

Easy to transport, the cutter arm of the brush cutter can be disassembled in less than 60 seconds. The complete machine can be carried in the trunk of an automobile. It is lightweight, has an automatic clutch, fingertip throttle control and a large gas capacity.

For more data circle **No. E4** on Readers' Service Card, last page this issue.



Winch

Braden Winch Company's new MS10-18B 20,000-pound capacity winch is now available. Recommended for every day tough jobs, its rugged construction and minimum weight make this low speed winch a leader in its class for 1½ to 2½-ton trucks. Besides the Braden oil-cooled automatic safety brake, the MS10-18B features a heat treated alloy steel detachable drum clutch plate. It has a thrust ring inside so that the worm housing will carry the thrust of the cable drum in either direction. A band brake on the cable drum and full cab controls for both drum brake and clutch are standard equipment on the MS10 winch.

The alloy steel drum shaft makes increased winch load capacity possible. The winch also incorporates the aluminum bronze worm gear and heat treated drum shaft keys.

For more data circle **No. E5** on Readers' Service Card, last page this issue.

Vapor Recording Instrument

A continuous, automatic method and instrument for recording low concentrations of water vapor in air or gas streams developed by the Research and Engineering departments of Mine Safety Appliances Company and Esso Research and Engineering Company offers a solution to moisture problems in gas pipe lines.

Operating on four-minute measuring cycles, the new method has been used in instruments with a full scale range of 100 ppm water by volume and it appears possible to operate satisfactorily with even lower full scale ranges. Instruments can be made which will record higher ranges. A sensitivity of 0.25 ppm by volume has been attained with accuracy limited by noise level and calibration errors to about 1 ppm.

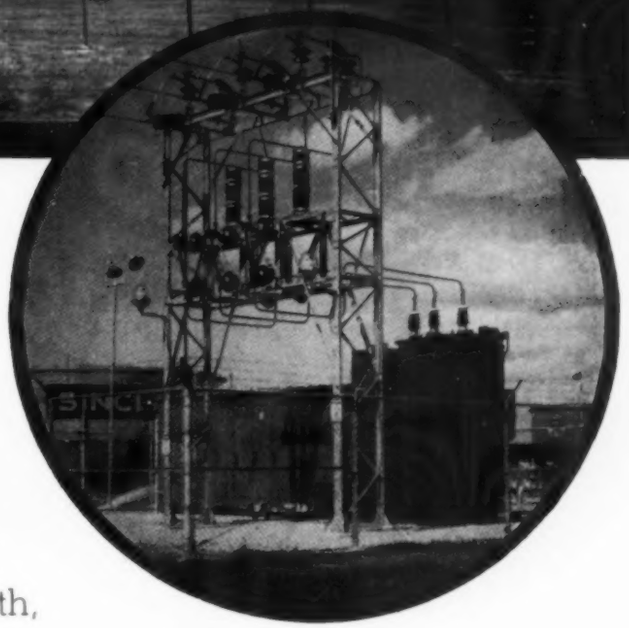
The method is said to be valuable in monitoring the dryness of natural gas in long pipe lines. The principle of operation is based on the heat energy exchanged when a gas is adsorbed on or desorbed from the surface of a solid adsorbent. The method was found to be more adaptable to continuous measurement and recording than existing methods such as the hair hygrometer, wet and dry bulb thermometer, electrical conductivity of hygroscopic liquids and salts and others.

A continuously flowing sample of gas is split into two streams, one being dried completely by a regenerative adsorption column. Both streams are directed alternately through two sides of a detector cell by automatically timed and operated three-way valves. During four-minute cycles the desiccant in each side of the cell is exposed alternately to each stream for two minutes.

A number of thermocouples in the two desiccant beds are connected in a circuit to develop an electrical potential. Since both adsorption and desorption processes proceed simultaneously, the resulting emf is proportional to the algebraic sum of the gain of heat on one side of the cell and the loss of heat on the other. During each half cycle the temperature differential in the cell rises rapidly, passes through a maximum and then diminishes slowly. When the maximum is passed, the flow is switched and moisture and temperature equilibration process is repeated. In the second half cycle the desiccant and stream which had lost heat in the previous half cycle gain heat and the reverse process takes place in the other side of the cell. The emf generated is equal but of opposite polarity to that of the previous half cycle.

(This item supplements Mine Safety Appliances Company data on pages 3370-3371 of the Composite Catalog, 21st Edition.)

For more data circle **No. E6** on Readers' Service Card, last page this issue.



From Key Station on down the line- Powered with Utility Electric Power! The biggest assets of Electric Power are dependability, efficiency and lower operating costs, utilizing remote automatic controls. Utility Electric Power also gives you smooth, uninterrupted performance — that's tailored for the individual job. It's also flexible enough to meet unforeseen requirements. Big or small — Utility Electric Power — fits them all!

CALL YOUR NEAREST ELECTRIC SERVICE COMPANY FOR POWER FACTS

Petroleum Electric Power Association

P. O. BOX 2771, DALLAS, TEXAS

ORGANIZED IN THE INTEREST OF GREATER SERVICE TO THE PETROLEUM INDUSTRY

For more data on advertised products, use Readers' Service Cards, last page.

Metal Tubing

Titeflex, Inc. is manufacturing a new type of lightweight, low cost metal tubing useful for ducts in the construction field.

Titeflex 500 is produced by a patented European process which winds a thin metal strip into a tube of the desired diameter with a smooth bore on the inside and helical ridges on the outside. This construction results in a tube that is light in weight yet has great strength and is resistant to external crushing forces. Made of lead-coated steel strip, the tubing is corrosion resistant, light and strong.

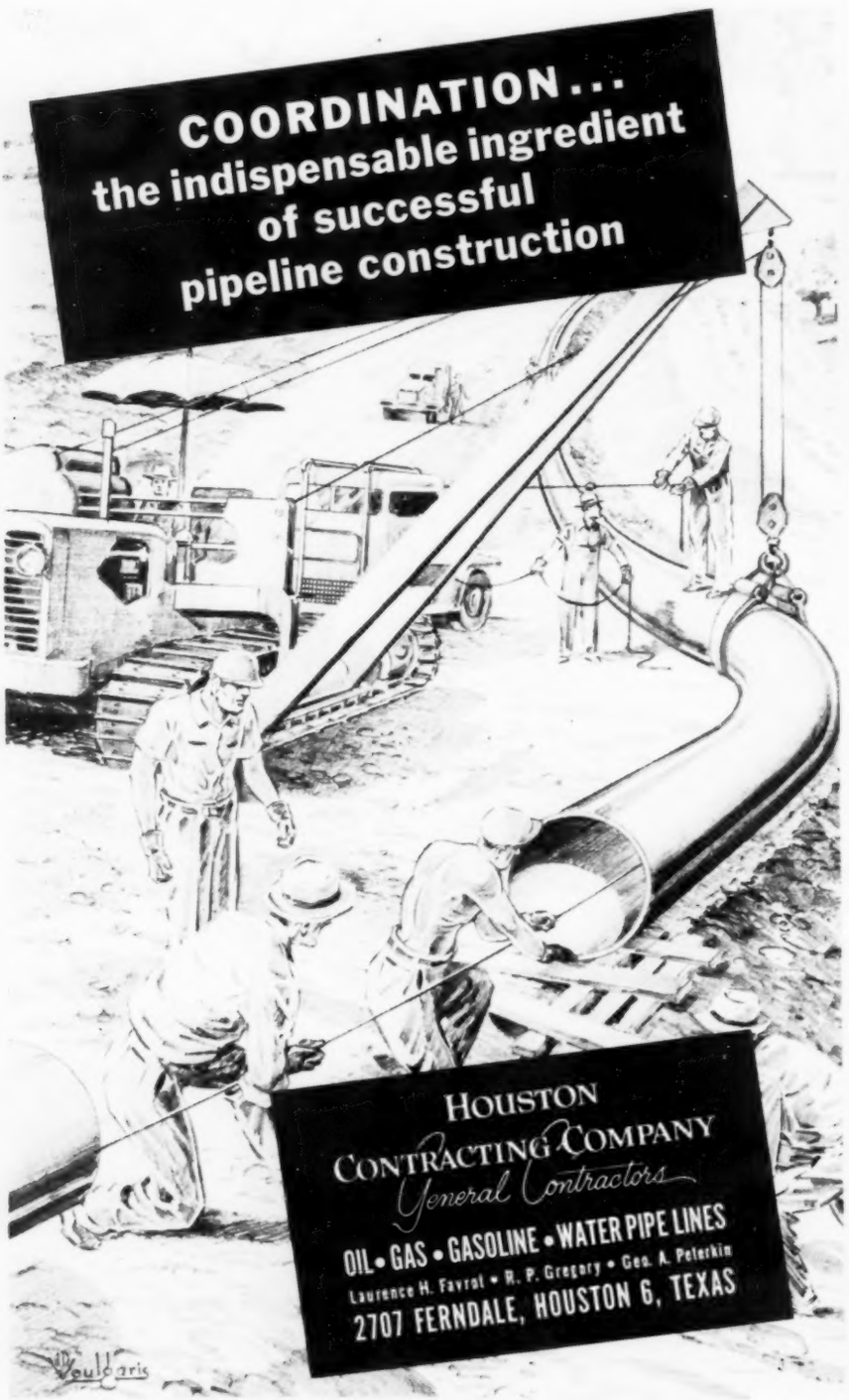
The new tube has a group of characteristics which makes it particularly advantageous for use in concrete construction. The external ridges give it a good grip, hence anchor it securely in the concrete.

Also the helical ridges make it stiff enough so it can be positioned securely inside concrete forms with a minimum of supports or anchorages. The thin gauge metal permits bending the tube by hand to fit complex layouts.

Titeflex 500 tubing is becoming widely used in the power and communication field for forming cable ducts in concrete-conduit housed underground power, telephone, or high frequency transmission (concentric cable) lines.

In addition to its use as a built-in duct in concrete, the corrosion resistance provided by the lead coating makes the Titeflex 500 tubing a good weather-protective dust for exposed wiring or piping lines. Sizes shown are ⅞-inch, 1-inch, 1⅛-inch, 1½-inch and 2-inch ID.

For more data circle **No. E7** on Readers' Service Card, last page this issue.



Bushings

Improved WmSEAL Z bushings for pipe lines in casing under highways and railroads are now available from T. D. Williamson, Inc., for all line pipe down to 2-inch.

New design features include stainless steel bands and clamps which provide a tighter seal and are hand tightened. This continuous solid ring of tough synthetic rubber which withstands the weight of backfill earth effects a perfect seal on bare pipe as well as on coated pipe. The extra thick shoulder incorporated in this design prevents the casing edge from cutting through the bushing.

Spliced Z bushings (including cold patch kit) are available for installation on lines already in service.

For more data circle **No. E8** on Readers' Service Card, last page this issue.

Joint Wrap

L. O. F. Glass Fibers Company has introduced a new pipe line joint wrap with almost double the tensile strength of the former product. Known as "Duratape," the joint wrap is a parallel-reinforced glass fiber mat, heavily coated on both sides with plasticized coal tar. It is designed for hand wrapping of field joints and fittings to form a long-lasting, tough barrier against corrosion.

For more data circle **No. E9** on Readers' Service Card, last page this issue.

The ALSTON Pipe Cutter is SAFER saves TIME and MONEY*

*Say hundreds of pipeline workers using the Alston Ratchet Pipe Cutter.

safer

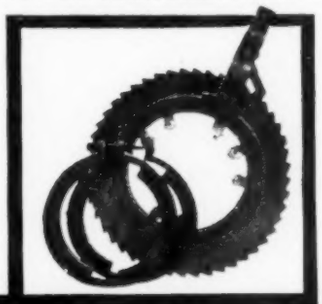
The Alston Pipe Cutter completely eliminates sparks . . . no line explosions. No more time consuming pipe bleeding.

quicker

This tool cuts 10-inch pipe in less than 15 minutes. Roller guides eliminate broken cutters. The ratchet makes working in close places easy.

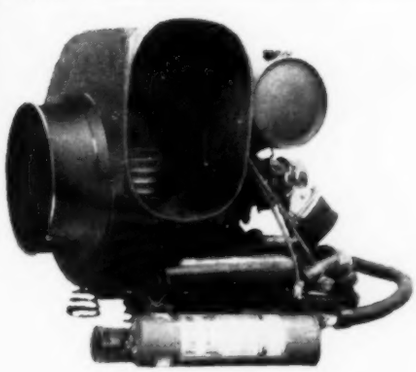
saves money

Begin to use this precision made cutter in your pipeline operation for safer, quicker, economical pipe cutting. Write for literature and prices.



ALSTON Manufacturing Co.

Livingston, Texas
P. O. Box 707 Ph. 226



HOME-LITE PORTABLE BLOWER
Gasoline Engine Driven
Model G—2,000 CFM

9-inch inlet, 11½-inch outlet. Flexible exhaust, pressure type. Ideal for Public Works Contractors, Pipe Line Contractors, underground work, or any place fresh air is needed. Can also be used to blow odors and gases out. Government Surplus. NEW. In original crates. Shipping weight 145 lbs. Net weight 80 lbs.

SATISFACTION GUARANTEED **$69.50** F.O.B., FORT WORTH, TEXAS

Quantities of 5 or more, only $50.00 each

NOTICE: If your check accompanies your order for Home-Lite Blower, we'll prepay the freight.

ENGINE & LIGHT PLANT CORP.
2508 W. Lancaster Fort Worth, Texas
Phone JEfferson 6-8318

NOTE ON COMPRESSOR MAINTENANCE

Keep 'Em Cool!

The efficient operation of your compressors — in fact, their *life* — depends on the removal of waste heat from lubricating oil and water cooling systems. The Whitlock Type SG Cooler is specially designed for such service. It is small yet capable of handling relatively high heat loads, and its standardized design means low cost and prompt shipment.

The cooler is two-pass in design and properly baffled to develop high fluid velocities and subsequent high heat transfer rates, with minimum pressure drop. Its non-ferrous tube bundle, cast iron channel and steel pipe shell mean long, trouble-free equipment life even under severe operating conditions. Bulletin 122 gives you the whole story on Whitlock Lube Oil and Jacket Water Coolers. For your copy, just fill in and return the coupon today.

Whitlock

WHITLOCK Designs and builds: bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers.

THE WHITLOCK MANUFACTURING CO.
98 South Street, Hartford 10, Conn.

☐ Please send Bulletin 122 describing Whitlock Lube Oil and Jacket Water Cooler — Type SG.

Name .....

Title .....

Company .....

Address .....

For more data on advertised products, use Readers' Service Cards, last page.

ON 150 MILES OF 18-INCH PRODUCTS LINE between Jacksboro and Teague, Texas, this Cleveland Model 320 Trencher is showing that its speed and capacity are profitably employed on medium and small diameter jobs as well as on the big 36-inch lines. It is one of several 320's owned by the River Construction Corporation of Fort Worth. There's a Cleveland trencher that will fit the requirements of all your pipeline jobs — large and small. Talk it over with your Cleveland distributor.

THE CLEVELAND TRENCHER COMPANY, 20100 St. Clair Avenue, Cleveland 17, Ohio

(Advertisement)

For Field or Office

We provide the fastest and most economical source of

PRE-PRINTED STOCK FORMS

Over 50 different forms are stocked for immediate shipment. These forms include pipe line run tickets, daily gauge reports, pipe tally forms, inventory forms, purchase orders, payroll sheets and inter-office memos.

Now in general use throughout the industry, these forms may be ordered in any desired quantity. Their utility and economy have been demonstrated by the thousands of satisfied users.

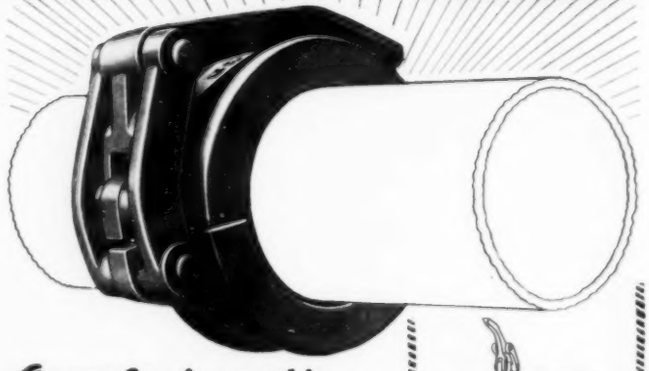
Stock Forms Dept.

The GULF PUBLISHING COMPANY

P. O. Box 2608

Houston 1, Texas

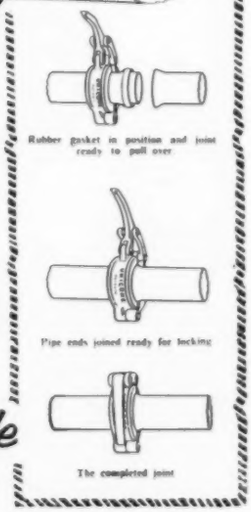
INSTANTANEOUS! JOINTS



A perfect seal in a matter of seconds

For temporary pipe lines 'Unicone' instantaneous joints are recommended. Comprising two parts only, they fasten with a "snap" ensuring a perfect seal in a matter of seconds.

For permanent or semi-permanent pipe lines 'Unicone' bolted type joints are usually employed and can be assembled far more quickly than any flexible joint giving positive anchorage.



Rubber gasket in position and joint ready to pull over

Pipe ends joined ready for locking

The completed joint

'UNICONE' REGD

Flexible Joints for all Pipelines.

Leakproof. safe. reliable

THE UNICONE COMPANY LTD.

RUTHERGLEN • GLASGOW • SCOTLAND

New Equipment Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card.

Heat Exchangers

A bulletin describing the latest developments in air-cooled heat exchangers has been published by The Griscom-Russell Company, subsidiary of General Precision Equipment Corporation. This new bulletin gives design details, construction, and application of the Griscom-Russell air-cooled unit known as the G-R fin-fan exchanger.

Also included are specifications, sketches of arrangements and descriptions of mechanical equipment and control apparatus for various service requirements. Another bulletin put out by the same company describes an extended surface design of heat exchanger with longitudinally finned tubes, the G-R Twin G-Fin Section.

To get a copy circle **No. E10** on Readers' Service Card, last page this issue.

Mechanical Seals

A complete line of chemically inert mechanical seals for handling all types acids, corrosives, solvents and gases is described in a new illustrated technical bulletin. The mechanical seals described are the "John Crane" types 9, 9B and 9A in the various construction styles in which they are available. These seals incorporate sealing members fabricated from DuPont Teflon to insure positive resistance to all chemical attack. Metallurgical construction is governed by the service specifications.

To get a copy circle **No. E11** on Readers' Service Card, last page this issue.

Truck Service Guide

Ingersoll-Rand has released a Truck Service Guide, a bulletin giving the truck service shop accurate time and cost comparisons in doing a number of common service jobs by hand and with air and electric power tools called Impactools. The studies were made in the field by Ingersoll-Rand engineers.

With this guide, a truck service shop can evaluate its present service equipment and determine the savings to expect through using Ingersoll-Rand air and electric Impactools.

To get a copy circle **No. E12** on Readers' Service Card, last page this issue.

Corrosion Prevention

Solvay Process Division of Allied Chemical & Dye Corporation has issued a 1956 edition of the company's booklet, "Sodium Nitrite for Rust and Corrosion Prevention." It contains data on the uses of sodium nitrite for corrosion prevention ranging from protection of hydrocarbon shipping and storage tanks, through the protection of metals in process and storage, to treatment of steel scouring pads for household use. Sections of the book cover the use of sodium nitrite combined with other materials for cleaning and/or neutralizing operations.

To get a copy circle **No. E13** on Readers' Service Card, last page this issue.

Chart Pen Combination

American Recording Chart Company has issued a new brochure explaining and illustrating features of chart pen design and operation. The new Arcco bulletin shows the beginner and the experienced fieldman the important features of various types of chart pens for permanent recording on instrument charts.

To get a copy circle **No. E14** on Readers' Service Card, last page this issue.

Compressor Catalog

A new engineering catalog describing the newest Cooper-Bessemer Type FMP compressor is available. The Type FMP reciprocating compressor is built for field pick-up service, gas boosting, air drilling and general industrial use. It is available with either single or twin frames, with single or multi-stage compressor cylinders. Ratings are up to 600 horsepower as belt-driven or completely packaged unit.

To get a copy circle **No. E15** on Readers' Service Card, last page this issue.

Trenchers

A 12-page data booklet on the Allen 16-60 Super Duty Trencher is available from John Allen & Sons (Oxford) Ltd. This literature gives complete descriptions, specifications, parts and application data on the newest and largest in the line of Allen trenchers. The 16-60 designation indicates a trench cutting width of from sixteen inches to five feet for this model which has a maximum trench depth of fourteen feet. Also available on request are data on the Allen 12-21 and 14-30 models.

To get a copy circle **No. E16** on Readers' Service Card, last page this issue.

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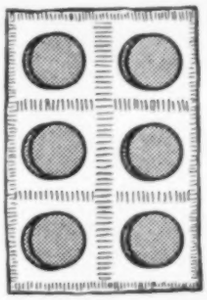

Simplest Safest Way To Keep Radiators and Entire Cooling Systems Clean

SAND-BANUM SPECIAL
CONCENTRATED TABLETS

SAND-BANUM

Pure Colloidal Concentrate
Ounces Only Once a Week
Remove and Prevent
Boiler Scale and Corrosion

Stocked by Leading Supply Houses
Gulf Coast District Representatives
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1717 Chenevert Street, Houston, Texas
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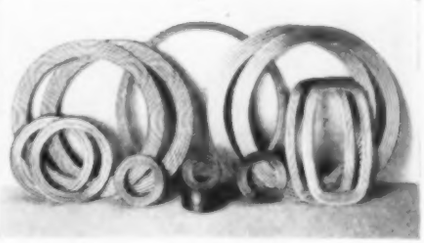
AMERICAN SAND-BANUM CO.
ESTABLISHED 1926
MEADOW BROOK NATIONAL BANK BUILDING
FREEPORT, NEW YORK

Need Plain or Jacketed
CORRUGATED METAL
GASKETS?



Call CHICAGO-WILCOX
for PROMPT ATTENTION

Chicago-Wilcox understands the gasket requirements of pipeliners and is equipped to supply all types of gaskets including plain and double jacketed corrugated metal gaskets as pictured, compressed asbestos, vulcanized hard fibre, rubber, and all other materials in all sizes and shapes.

Send specifications for quotations and prompt-delivery schedule.

CHICAGO-WILCOX MFG. CO.
7705 Avalon Avenue, Chicago 19, Ill.
Phone: SAginaw 1-1900

NEW

TRUCK PERFORMANCE WITH **UNUSED** *ORIGINAL GOV'T SURPLUS* NEW- GUARANTEED 6 x 6's

Before You Buy

Do yourself a favor . . . Call us COLLECT — TEmple 5-4477 . . . Ask for *Sid Lieberman* or *Rich Medlock*. We can offer you the best TRUE VALUE — *Quality* as well as *Price*.

ALL ORDERS ACCEPTED

Subject to your inspection and approval at time of delivery.

A recent statement made by one of the larger pipeline contractors: "I have purchased and inspected government surplus 6 x 6's at practically all of the surplus dealers. I can honestly say that I have gotten better service and value out of the processed 6 x 6's purchased from Zeligson."

SATISFACTION GUARANTEED

World's Largest Dealer of Unused Gov't Surplus Trucks

Write for latest complete military parts catalog.

ZELIGSON
TRUCK and EQUIPMENT COMPANY
2707 E. ADMIRAL PLACE TULSA OKLAHOMA
PHONE TE 5-4477 SPECIALIZING IN
TANDEM ALL WHEEL-DRIVE 6X6 TRUCKS

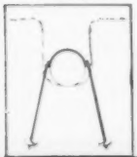
Here's the Fast Easy Way to Anchor Pipelines

No heavy equipment to haul. Cuts costs to a fraction.

Chance Pipe Line Screw Anchors and Brackets greatly simplify pipe line anchoring, compared to other methods, and save many dollars in pipe line construction.

Chance Pipe Line Screw Anchors can be installed in pipe line ditches without extra digging. Using a power wrench the operator merely guides the anchor in place. The tool does the work.

Can be installed in the ditch without extra digging.



Write for catalog showing oil industry applications of Chance Earth Anchors.

A·B·CHANCE CO·
CENTRALIA, MISSOURI
TORONTO, ONTARIO, CANADA

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use these
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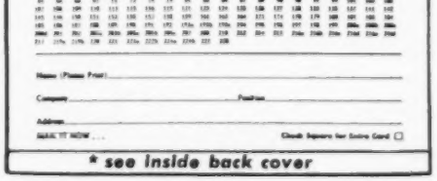

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REPLACEMENT PARTS and REPAIRS

An Outstanding Service Designed to Solve Your MAINTENANCE Problems!

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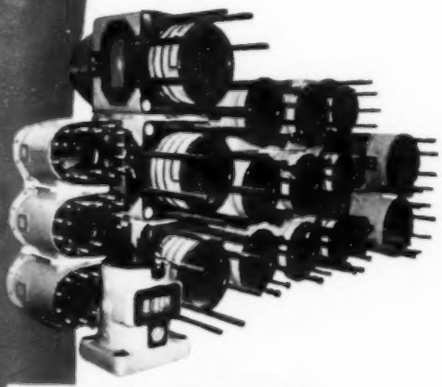

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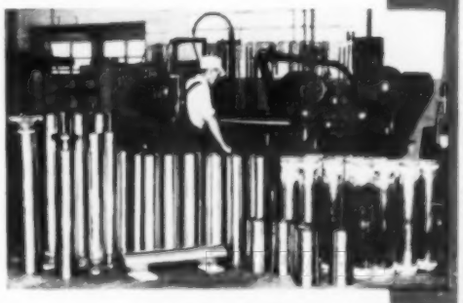

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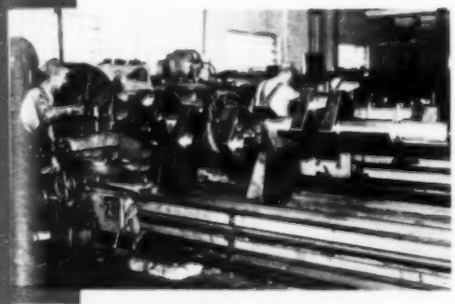

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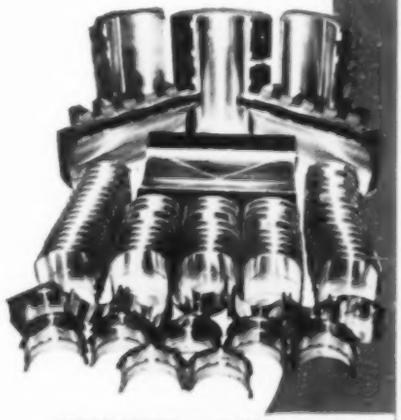

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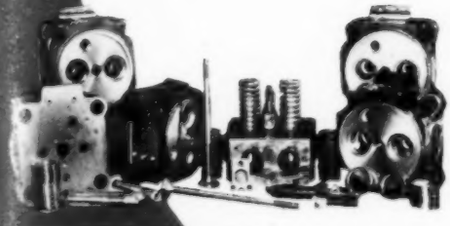

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